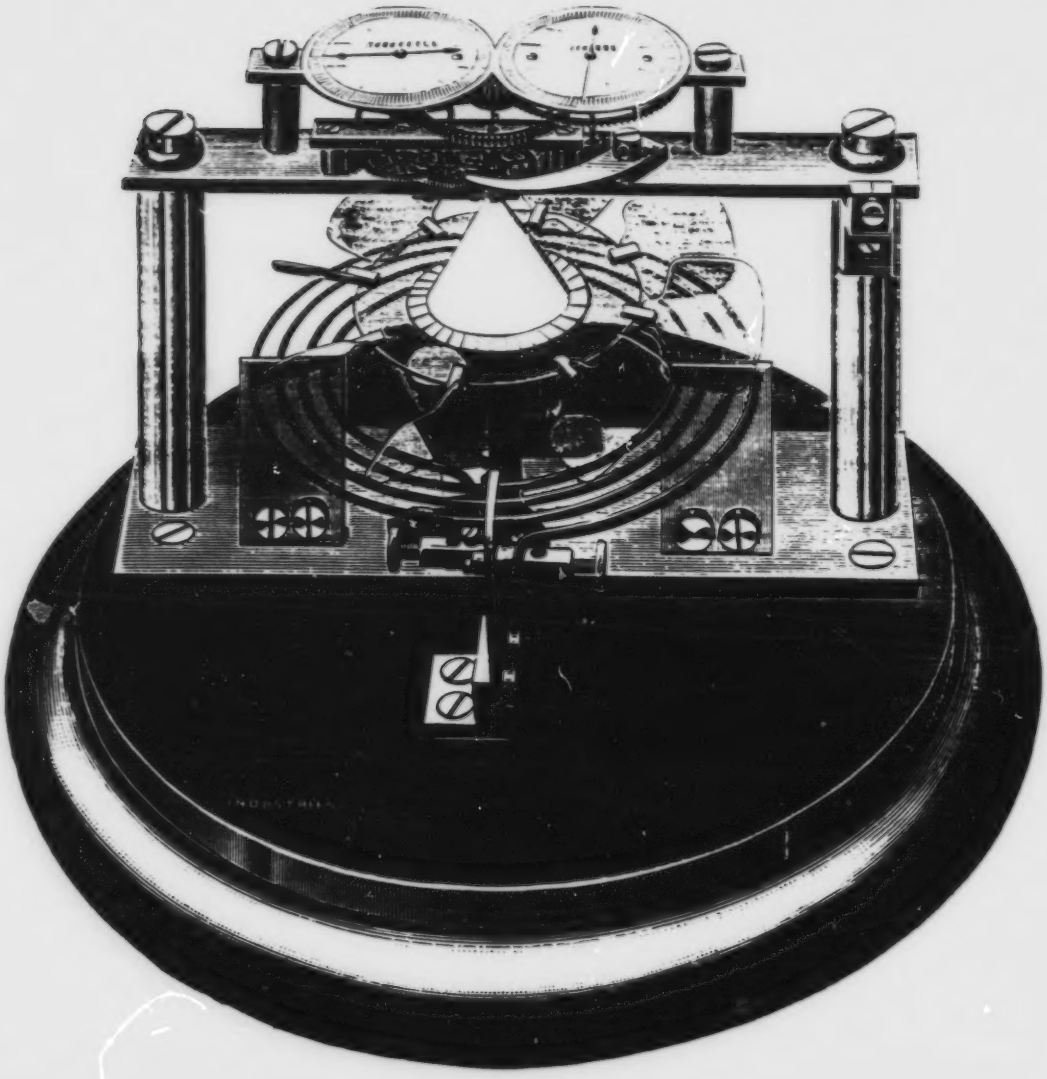
REPORT ON THE DEVELOPMENT OF CANADIAN TELEMETRY OPPORTUNITIES FOR DISTRICT ENERGY SYSTEMS



Final Report

by
Tom Bowling and Associates

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THE DEVELOPMENT OF CANADIAN TELEMETRY OPPORTUNITIES FOR DISTRICT ENERGY SYSTEMS

Author:

Keywords: District Heating, Automatic Meter Reading, Demand Side Management, Telemetry

Abstract:

In a previous report, completed in 1989 for the International Energy Agency ("A Technology Assessment of Potential Telemetry Technologies for District Heating" IEA/1990R7) it was concluded that the use of remote telemetry techniques for automatic meter reading were not cost effective as compared with manual methods and that only if several different utilities (say gas, water, electricity and district heating) were to share the telemetry system, would economies occur. Further, if the system were two-way, significant savings would accrue to electrical utilities in the introduction of demand side management opportunities. North American (and, in particular, Canadian) technologies have been researched, the status of proposed or current multi-utility trials in Canada have been investigated and finally, initiatives for a multi-utility trial in Toronto, Ontario, are described.

DEVELOPMENT OF CANADIAN TELEMETRY FOR DISTRICT ENERGY SYSTEMS

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1. EXECUTIVE SUMMARY

Fifty percent of a water utility company's water disappears – and it's not known where. An undetected gas leak in a twenty-two story apartment block causes an explosion that cascades the building. The first an electrical utility knows of a distribution failure is when irate customers telephone.

Electrical utilities lose $4.5 billion a year due to power thieves – Florida Power and Light alone lost $5 million in 1990.

Visual meter reading costs are reported between 22¢ and $10 a read; accurate quantification seems impossible.

The telephone – which accesses virtually every home, is hardly ever used for Automatic Meter Reading – due to the un-innovative attitude of the telephone companies – and never for load control, where folk-law has it that "the telephone network cannot be used in a broadcast mode".

And anyway, North Americans resent intrusion and control in their lives – "61% of Americans believe that computer usage and the information banks they make possible pose a 'serious threat' to personal privacy."

Finally, it's all too expensive for a utility to introduce an Automatic Meter Reading System – let alone a two-way a load control capability.

Yet all these problems are soluble. There are many technologies which are appropriate to the remote metering, monitoring and control of electricity gas, water, district heating - even oil, sewage and pay-per-view television.

There are even technologies - being proven in the field, now, to provide the telephone industry with the broadcast, mass-addressing capability, that is, the ability to disconnect, for short periods, non-essential appliances in homes in order to reduce peak demand.

The demands for energy conservation, environmental control and safety are remorseless, and only to be met by comprehensive control using shared communications.

> "We will ask Ontario Hydro to divert planned expenditures for new nuclear development towards the most comprehensive energy conservation and efficiency program ever undertaken by a utility in North America".

says the Lieutenant-Governor of Ontario in his speech from the Throne.

Public Utility Commissioners are becoming increasingly vocal and are proposing draconian measures to share a communications network (they'd mostly prefer the telephone) amongst several different utilities.

Canada is in an ideal position to marry technologies. We have one of the world's finest telecommunications industries, the utilities areas are large and contiguous, and we are the largest users of energy per capita in the world. (Figure 1) (48) We are internationally respected for our solicitousness to environmental concerns.

And there's money in it for Canada – in encouraging the fledgling metering and communications industry, in sharing plant and facilities and in making available expensive software control and management programmes to other users.

There could be a new, turnkey industry providing all these services and facilities, not only in Canada, but also in the United States where already there is some envy over our Multi-Utility Service Trial plans.

Abroad, the whole of Eastern Europe and the Commonwealth of Independent States are profligate with their use of energy. Systems lack monitoring and control to manage their resources. There is great export potential for us here.

Finally, a new concept (for Canada) is that of district energy — considering energy supply, use and opportunities for efficiency and load management on a regional or community, that is to say district basis rather than only from the perspective of the individual energy user or process. These combined heat and power plants (CHP) can achieve over 85% efficiency compared with electric only efficiencies of about 35%. (151,152,153)

The heat used can displace the fossil fuels used for space heating in individual buildings and a reduction in total fuel burned and CO_2 produced of about 40% can be anticipated. (149)

Systems with wood as a prime fuel can claim to eliminate, totally the production of CO_2. The Charlottetown, P.E.I. system is an excellent example of this. (150)

These district energy projects — and more are planned, including Kingston, Ontario, Edmonton, Alberta and Vancouver, B.C. — offer further opportunities for comprehensive telemetering systems for control, performance monitoring and optimization.

This report tells what is going on in Canada, what trials of interworking may be possible and charts a way in this large, growing and rewarding (in more ways than one), new hybrid industry.

2. INTRODUCTION

"Electricity is going to be so cheap that it's not going to pay to meter it" said Charlie Steinmetz, GE's genius electrical engineer in the early years of the century. "Energy so cheap that it will be given away" said the designers of nuclear reactors in the heady days of the 1950's.

But it hasn't happened and it will be unlikely to do so. Nuclear power is perceived as too potentially dangerous and reactor costs increasingly unpredictable, fossil fuels are environmentally destructive, photo-electric power too inefficient and wind power too expensive.

Nuclear power suffered its first reverses in the sixties, with Britain's problems with the AGR and Magnox reactors, through Three Mile Island and was eventually finished off by Chernobyl in the minds of the public - so much so that it is now a non-starter. Few countries are seeking to expand their nuclear programmes; many have done the opposite, some determining to phase out nuclear power, at least one not allowing a completed station to start up. (106)

Environmental concerns are inhibiting fossil fuel generating station construction, and demanding emission improvement. The Clear Air Act amendments of 1990, which require two new rounds of sulphur emissions reduction, one commencing in 1995 and the other in 2005, will require comprehensive energy control - delaying the bringing on line of the many inefficient coal, oil and gas fired plants. "We must implement Demand Side Management rapidly - if for no other reason, than as an insurance policy against continuing environmental degradation" Says David Wolcott of the New York State Energy Research and Development Authority. (143)

Photovoltaic technology is advancing. Solar cell production is anticipated to have an annual growth rate of 20% resulting in an industry of between $5 billion and $10 billion - production is extremely cost-volume sensitive. (107)

Windpower is just beginning to be taken seriously. Pacific Gas and Electric, California's largest utility, will purchase most of the 2.5 billion kilowatt-hours each year from the state wind farms. (108)

All governments at every level, are concerning themselves with the problem of maintaining and increasing energy production whilst improving the environment. Figures 2 and 4)

2.1 North American Opportunities in General

The United States Department of Energy spends $2.2 billion annually on civilian energy research and development (110), apart from other federal, state and industrial consortia efforts.

In the most authoritative U.S. assessment to date of policy options to combat the "greenhouse effect", the National Academy of Sciences said last April that by more fully exploiting current technologies over the next thirty years, the United States could reduce by as much as 40 percent its emissions of industrial gases blamed for trapping solar heat and raising the Earth's temperature. (111)

At the distribution level of electrical energy there are many schemes and initiatives for "manageable energy management" - Smart Energy, DEED, Kilowatchers Plus, Watt Watch, Green Lights, Good Cents, Smart Light, Lightwaves, Lease-a-Light, Neighbour $ave being typical. (112)

One of the most ambitious and successful schemes is Canadian - the PowerSmart project introduced by British Columbia Hydro and Power Authority and used by thirteen Canadian Utilities and five in Czechoslovakia. Disappointingly, there are not yet any United States clients.

Power Smart is a comprehensive turnkey programme encompassing complete utility energy services, addressing the residential, commercial and manufacturing sectors. Not particularly 'high-tech', some twenty five programmes are offered, including new building design, buy-back programmes, conversions of some electric appliances to gas ("Dual Fuel"), customer rebates, dealer incentives and, for commercial customers, rebates on efficient lighting, energy control systems, and high-efficiency motors. Figure 5 shows the Power Smart prospectus.

The whole project has cost British Columbia Hydro approximately $20 million.

The most obvious, logical way of controlling energy should start with good communications. Yet, good, integrated, multi-utility communications for monitoring and control does not yet exist.

Endless trials are mounted, every type of communication essayed, yet no national, multi-supplier initiative has resulted. Some measure of the number of trials in being, or recently completed, in Canada are tabled in Section 3.4.

The preliminary results of some recent trials are tantalizing; TranText, for one, has documented a 23 percent drop in electricity peak consumption with the utility making more money and the consumer spending less. (99) Sadly, as Steve Rivkin goes on to say - "The system's ability to make dramatic energy savings has been proven in field trials, but its speed has been shown to be limited by the design of the telephone plant".

Perhaps the conservation of energy and the improvement of the environment is so important that the telephone system should be re-structured to make control and monitoring its most important function, subordinating voice to a secondary role.

Leadership in these matters is being shown by the Public Utility Commissioners, from Integrated Resource Planning (Figure 6) (134,135,136,143) through to an insistence on integrated communications planning.

As Stephen Brown, Chief of the Bureau of Energy Efficiency, Iowa Department of Commerce says -

> In fact, the overriding goal of new-power-plant design is not improved efficiency, but to minimize the plant's impact on the environment. Therefore, the market for load control will not be threatened by new power plants, and the electric industry will always be called on to manage consumption at the distribution level. This is exactly where load control is cost effective and explains why Automatic Meter Reading software and hardware should incorporate load management capabilities. Although power-plant technology is stagnate, it's not the only force behind load management; federal environmental legislation and state energy policies are also pushing the electric utility industry to manage the public's consumption of electricity."

There is determination by the P.U.C.s to prevent needless and wasteful multiplication of parallel services by telephone, CATV, Power Line Carrier and Radio.

Bill Tucker, Chairman of the Wyoming Public Service Commission says -

> "I am speaking not of new divisions of an existing pie, but rather of a new and much larger pie with benefits for all of those entities becoming part of that pie. Electric, gas, water, cable TV and telecommunications providers will all,

through cooperation, experience the benefits of increased cash flow, decreased bad debt expense, remote customer connect and disconnect, instantaneous load and consumption monitoring and control and direct customer interaction amid other benefits not even envisioned today. We must immediately begin to place automatic meter reading and control technology to work for the vast majority of utility systems in the United States."

Certainly, the Commissions see the telephone as the medium of choice -

"ARMR [AMR] can enable the metered utilities to eliminate estimated billing, eliminate special readings, streamline the billing process, detect theft of service and obtain consumption data. In addition to utility meter reading, the system provides the potential for load shedding or energy management. .... In this age of technological advances which brought us two dollar clocks and five dollar calculators, it seems to reason that a remote meter reading system should be economically feasible. We believe, and we hope the Commission concurs, that the use of [AMR] systems should be encouraged. Cooperation among the various metered utilities and the telephone industry is essential if these potential benefits are to ever be realized."

[John Coleman, Utility Management Analyst
New York State Department of Public Service] (53)

Let Chairman Brown have the last word here -

Why wouldn't (the industry) sell the device to the utilities; why wouldn't they buy it? Would the best of all worlds be where the telephone company sells meter-like devices to utilities which then use telephone lines to conduct load

management and measure consumption? Just because this hasn't happened in the past, doesn't means it can't happen in the future. *A Baby Bell*[1] *would definitely have the potential to dominate the AMR market if the company acquired a meter manufacturer.*

[Stephen BROWN, ibid, the italics are this writer's]

The communications industry will have to get its act together before the final curtain - and all the lights go out.

2.2 Overseas Opportunities

2.2.1 United States

"There's nothing like it down here", "You're further advanced than we are" "I wish we had your opportunity" said a U.S. Public Utility Commissioner and a senior engineer in a water utility to the writer, regarding what is happening in Canada with our Multi-Utility Service Trials.

It is a Canadian Company, Iris Systems Inc., that is co-operating with Northern States Power, in Minneapolis to introduce a multi-utility trial in that city. (66) It would be hoped that district heating could be involved - the District Energy of St. Paul is only a radio hop away and radio is to be the communications medium for the trial.

---

[1]Regional Bell Operating Company

There must be many opportunities for our industry in the United States. Our utilities have developed, at great expense, software for the control and management of multi-utility trials. This valuable investment could be utilized in a consortium offering to any proposed U.S. multi-utility trial.

2.2.2 United Kingdom

There is to be an interesting development in the United Kingdom soon. A requirement of the Government there is that there will be a "free market" in electricity supplies by 1998 - that is, that any customer, even at domestic level, can have a choice of supplier. This is exercising minds greatly, especially as to how metering for this scenario will be arranged.

Theft of service is of growing concern. Electricity Board official secretly fear that their practice of reading meters at routine intervals means that many apparently law-abiding citizens may have been quietly cheating for years. They also admit that they have no way of knowing how much revenue is being lost each year. The most conservative estimate is $2 million a week. (125)

It is claimed that, by April 1998, all 22 million electricity meters in the United Kingdom will have freedom of choice over their electricity supplier. To make this possible, they will need a meter able to take readings on a half-hourly basis, and access to a communications infrastructure able to transmit these readings to a billing centre.

Radio and mains-borne signalling are seen as the two most favoured options for data transmission - there is no mention of the telephone, yet the penetration is high, (virtually the same as Canada's) it is more likely due to British Telecom's recalcitrant attitude towards AMR/DMS. (147)

2.2.3 Europe

Previous work by Canada for the International Energy Agency shows that there is great interest by European Utilities in the many techniques for Automatic Meter Reading and Demand Side Management available in North America.

A variety of techniques and technologies are being investigated, although "in few of these European experiments is a telephone company directly involved". Noteworthy is that the Europeans are motivated chiefly by customer's concerns for security, lack of access to meters, and "inability to secure co-operation from local telephone companies" (124).

2.2.4 Eastern Europe and the Commonwealth of Independent States

Inefficient fossil-fuel power stations, creaking nuclear power generating units, the closure of many low-grade plants all represent opportunities in telemetry and control. There are certainly opportunities in Czechoslovakia.

In Russia there has been no incentive to save energy, subsidized as it was by the State. As "Le Monde" says, "The consumer can reasonably be expected to pay for the real cost of energy only when obsolete and leaking urban heating systems have been renovated. In other words, energy saving programmes should be implemented before the notion of realistic pricing is introduced." (55)

Geographically, geologically and climatically Canada and Russia are similar - and they are our closest neighbours outside North America. It is important that some *entente* be established to encourage energy management systems deployment - we'd all benefit.

Perhaps through the good offices of the International Energy Agency, Canada could explore these opportunities more fully.

2.2.5 Australasia

Much innovative work in Automatic Reading is being performed in Australia, using a variety of communications techniques. An example is the use of Sequential Waveform Distortion (SWD) as a method of overcoming traditional high voltage power line carrier disadvantages. (126,127,128) Siemens recently launched an Australian designed and manufactured system for remote control and monitoring of electricity gas and water meters, using a combination of paging and dial-up data transfer. Siemens "hopes to export the technology to the U.S.A." (148) Perhaps a Canadian company could investigate an opportunity here?

3. The Present State of Multi-Utility Telemetry in Canada

3.1 Overview

It has not proved possible to produce an exhaustive list of Canadian trials, in many cases due to the time which has elapsed since the trial conclusion. Examples are the Oshawa trial of 1975 and the Manitoba 'Ida' trial of 1978.

The inevitable promotion or retirement of key staff within the utilities, and not unnaturally a disinclination to discuss failed or inconclusive trials have all made the task difficult.

3.2 Current Provincial Activities

For the few trials in progress (See Section 3.4) the project leaders have been most forthcoming with information, although naturally definitive results are not available.

Negative information has been inferred from the few trials in the process of planning and deployment. Equipment failures have occurred in the harsh Canadian winter environment, testing, labelling and sealing of meters by the authorities has been delayed and finally, and most importantly, the inter-utility discussions and agreements required in order to decide relative financial sponsorship, legal responsibilities and material and labour deployment have exercised the utilities intending to be involved in the trial and resulted in many meeting over long periods.

Two excellent papers have been presented recently on these contentious areas however, which can act as excellent trail-blazers for other utility groups -

"Multi-Utility Partnerships - Trial Agreement" by Paul Arsenault of Manitoba Telephone System and Ted Cotton of Manitoba Hydro

"Vendor and Product Selection Process" by Mike Cawood of Sasktel International.

These are thought sufficiently important as aide memoirs to be included as Appendices II and III to this report.

An excellent guide to establishing an Automatic Meter Reading System has been prepared by the Itron Company. (130) As Dr. Donald Schlenger, Vice-President, Business Development, United Water Resources says "Joint trials are a good place to start". (59)

3.3 The Proposed Toronto Multi-Utility Trial

A recent initiative by Toronto Hydro has resulted in a proposal for a multi-utility Automatic Meter Reading (and probably Load Management) trial in downtown Toronto. This trial proposal is mentioned specifically in that the trial planning is current, four different utilities could be involved, the communications medium is completely undecided and, finally Federal Government interest is being expressed in the trial.

In a Load Management/Automatic Meter Reading implementation cost/benefit report, Toronto Hydro mentioned the following as benefits that could result from improved load management:

- Reduction of monthly maximum system peak demand, thereby reducing payment of demand charges to Ontario Hydro.
- Reduction of loading on the distribution system, possible deferring capacity increase requirements.
- Improvement of system load factor as a result of the shifting of peak demand.
- Emergency load reduction capacity could be increased for relevant circuits to temporarily relieve overload.
- If the load management capability proves effective, it could conceivably be incorporated into system load forecast, and may help to defer system capacity increase requirements.

Originally it was envisaged that only the electrical and water authorities would be involved, but, with increased interest from Consumers' Gas and from the Toronto District Heating Corporation a four-utility trial is now envisaged - electricity, water, gas and district heating. Monitoring of the trial by Ontario Hydro and the Department of Energy, Mines and Resources of the Government of Canada is also hoped for. It is intended that the results of the trial be made available to the utilities in the Greater Metropolitan Toronto Area.

The location of the trial is shown in the map of Figure 7a, bounded by Davenport Road, Parliament Street, Dundas Street and University Avenue. The possible inclusion of the Toronto District Heating Corporation with its service area as shown in Figure 7b may increase the trial area to the southward.

In the first three months of the first phase, two hundred load management devices will be installed, grouped for load control or accessible individually. The load control communications will be required to be two-way in order to allow for status checking on the control devices.

For Automatic Meter Reading, approximately two hundred electricity meters, fifty water meters, fifty gas meters and (possibly) ten district-heating meters could be accessed.

The electrical AMR meter will be connected directly to the communications network, with the other types of meter either being connected via the electricity meter or directly to the network.

Most electricity customers will be residential whilst a small proportion may be commercial.

The focus of the first phase will be to ensure ease of installation and maintenance, the robustness of the communications system, ease of operation of the LM/AMR System, the

reliability and accuracy of remote meter reading and finally, the reliability of the load control function.

With successful results from the first phase, the second phase will be extended to other metering load management functions including Time Of Use KWh consumption, peak KW power, voltage, gas pressure, water flow rate etc. Tests of various load management strategies will also be performed, including short-term prediction of system peak, randomised customer load restoration and effective load reduction techniques. As an action from a Toronto Multi-Utility meeting held in August 1991, a questionnaire was prepared and circulated. A copy is enclosed as Appendix IV.

Finally, Toronto Hydro have defined benefits which could accrue from the provision of an AMR system as follows:

- Elimination of costly final and special reads which at present require actual visits outside of the routine meter reading routes to the customers' premises.
- Potential for revenue generation due to improved cash flow.
- Savings from billing administration - accurate readings from AMR would greatly reduce bill complaints - and regular meter reading.
- Intangible benefits would include improved customer relations, reduced regulatory pressure, and improved company morale.

The three primary areas driving the economics of AMR in Toronto Hydro are:

Existing Meter Reading Costs

- salaries and fringe benefits
- equipment
- facility and vehicle cost
- overhead and administration

Customer Service Impact

- cost of special reads (complaints)
- processing letters and calls
- responding to regulatory inquiries
- public relation benefits

Revenue Losses

- uncollectible due to accumulated errors
- lost time value on infrequent billing
- lost time value on read to bill delays

An AMR system, like office automation, allows a utility to provide a much higher level of service to the customers. As Toronto Hydro is in the "service industry", the intangible benefits are as important as the economic benefits.

A draft functional specification for the trial is shortly to be completed (120). With the agreement and support of the participating utilities, its is hoped that the trial could commence

in the second quarter of 1993. Already a questionnaire has been prepared (Appendix IV) and issued to possible participating utilities.

3.4 Trial Information

The following report forms show our understanding of current trials - recently completed, underway or being planned. The list is not exhaustive.

3.4.1

TRIAL	TECHNOLOGY	TRIAL SIZE
TORONTO Multi-Utility Service Trial	UNDECIDED	200 load measurement 200 electric 50 gas 50 water 10 district heating
		START **FINISH** Undecided

UTILITY	CONTACTS		
ELECTRICITY **TORONTO HYDRO**	Mr. Kah-Fae Chan[1] Toronto Hydro 14 Carlton Street Toronto, Ontario M5B 1K5 (416) 591-4589	Mr. Gerry Mead Section Head Ontario Hydro, C25-F4 700 University Avenue Toronto, Ont M5G 1X6 (416) 592-3409	Mr. Ron Horton Section Head Ontario Hydro 700 University Ave C25-F4 Toronto, Ont. M5G 1X6 (416) 591-8911
GAS **CONSUMERS' GAS**	Mr. Glen Williams Residential Marketing Consumers' Gas P.O. Box 650 Scarborough, Ontario M1K 5E3 (416)	Mr. Gerry Dennis Residential Marketing Consumers' Gas P.O. Box 650 Scarborough, Ontario M1K 5E3 (416) 495-6182	Mr. Don Eagleson Residential Marketing Consumers' Gas P.O. Box 650 Scarborough, Ontario M1K 5E3 (416) 495-5893
WATER **TORONTO CITY WATER DEPARTMENT**	Mr. Thomas R. Irwin Project Leader, Water AMR, City Hall 17th Floor, West Tower 100 Queen Street West Toronto, Ont, M5H 2N2 (416) 392-1520		
DISTRICT HEATING **TORONTO DISTRICT HEATING CORPORATION**	Mr. Alex Bystrin Director of Engineering Toronto Dist. Heat. Corp. 100 Adelaide Street W., Suite 505 Toronto, Ont, M5H 1S3 (416) 392-6838		
EQUIPMENT SUPPLY **NOT YET DECIDED**			

NOTES

(1) Toronto Hydro will be project prime, with management by Tom Bowling & Associates

(2) All above information is provisional and will be better defined at a joint meeting to be held in March 1992

(3) A functional specification has been drafted by Toronto Hydro

3.4.1 cont'd

TRIAL	NARRATIVE

3.4.2

TRIAL	TECHNOLOGY	TRIAL SIZE
CITY OF SASKATOON Automatic Meter Reading and Consumption Management Trial	Remote Out-of-Band Interface (R.O.B.I.); see narrative	45 points **START** **FINISH**

UTILITY	CONTACTS	
ELECTRICITY **CITY OF SASKATOON** (55,000 electric meters)	Mr. Ron Laturnas Manager, Treasury Systems CITY OF SASKATOON City Hall SASKATOON, Sask., S7K 0J5 (306) 975-2674	Mr. Rob Redekop Electric Department CITY OF SASKATOON 322 Brand Road SASKATOON, Sask., S7K 0J5 (306) 975-3153
GAS		
WATER **CITY OF SASKATOON** (55,000 water meters)	Mr. Vern Dyck Water Treatment Plant CITY OF SASKATOON Saskatoon, Sask., S7M 1K5	
TELEPHONE **SASKTEL**	Mr. Harry Chow SASKTEL 9th Floor, 1945 Hamilton Street REGINA, Sask., S4P 3Y2 (306) 777-1902	
EQUIPMENT SUPPLY		

NOTES

3.4.2 cont'd

TRIAL	NARRATIVE
CITY OF SASKATOON Automatic Meter Reading and Consumption Management Trial	The Remote Out-of-Band Interface - Description

ROBI (Remote Out-of-Band Interface) was initially developed as a solution for SaskTel R&D's interactive video-on-demand projects. ROBI was meant to be used to monitor video commands from the home subscriber (i.e. choose movie, pause, rewind, etc.) ROBI bridges onto the subscribers phone line without affecting simultaneous use of ROBI and the phone. It was soon discovered that it could also monitor meter reading information, and the Saskatoon ROBI trial with the City of Saskatoon (water & electric meters) was initiated in December 1990. The signals are transmitted out of the range of the normal voice band, hence the name ROBI. The ROBI data does not travel all the way back to the telephone central office, the data being transmitted to a RDCU (ROBI Data Concentration Unit) at the SAC location, and then to a processing computer. ROBI automatically sends the meter readings back every 5 minutes, which is ROBI's strong point. This means that the database, if required, can be updated every 5 minutes; there is no need for on-demand reads as the database is always up-to-date. This capability allows the utilities the ability for consumption management (introducing variable rates, tracking load profiles, streamlining power output, etc.)

ROBI was developed by SaskTel. Develcon Electronics Ltd. of Saskatoon is under contract to refine and manufacture the prototype equipment for SaskTel. Because SaskTel has control of the ROBI technology, custom requirements can be developed for the utilities (ie. voltage monitoring, alarms, etc.).

The Saskatoon ROBI trial ends on June 1, 1992. SaskTel is deciding whether or not to continue the development of ROBI into a viable product. This will probably depend on their utilities' need for ROBI's consumption management capabilities. If SaskTel decides to continue ROBI development, the earliest viable service deployment with product will be in the 1995 time frame.

In discussions with the City of Saskatoon, the ROBI trial partners, SaskTel agreed that ROBI is a long-term solution for both consumption management and AMR, and would be the way to go. The City of Saskatoon has come up with various revenue generating ways of using the ROBI data (ie. selling the consumption data to their commercial and industrial customers). SaskTel is in the process of negotiating with SaskPower, City of Regina, and SaskEnergy to join in the consumption management/AMR part of SaskTel's video-on-demand trial in Regina. The video-on-demand portion of the trial is ongoing, the consumption management trial using ROBI should be on its way by September 1992. They are very hopeful that the utilities will find that the ROBI capabilities are a long term solution for consumption management and AMR, not just a short-term solution as AMR alone, would be. It is hoped to expose the utilities to the usefulness of getting constant ROBI data, and for the utilities to convince themselves that they could use this ROBI data for many new creative revenue generating, cost reducing and streamlining purposes that have not been discovered yet, especially by a telephone company. The ROBI system enables the utilities to introduce variable rates as a voluntary method of consumption management, and can generate increased revenue from those that tend to abuse consumption. Variable rates will enable the utilities to win in three important ways:

1. This increased revenue will offset the huge costs required for new power plants.
2. The variable rates will also flatten out the peak demand which will help defer the huge capital and operating costs of building these new power plants.
3. Because 70% of Saskatchewan's power plants are coal producing, environmental pressures will probably cause stricter guidelines. The cost of new pollution control technology for these plants could increase costs of the power plants by hundreds of millions of dollars. Consumption management will offer excellent public relations opportunities for the utilities.

3.4.3

TRIAL	TECHNOLOGY	TRIAL SIZE
RICHMOND HILL (ONTARIO) Multi-Utility Service Trial for AMR & DSM	TWO-WAY CABLE TELEVISION	30 points[1]
		START Jan.'92 **FINISH** Jan.'93

UTILITY	CONTACTS	
ELECTRICITY **ONTARIO HYDRO[1]**	Mr. Gerry Meade ONTARIO HYDRO 700 University Avenue, C25-F4 Toronto, Ontario M5G 1X6 (416) 592-3409	
GAS **CONSUMERS' GAS**		
WATER ?		
CATV --	Mr. Glenn Dawe Manager, Technical Services CLASSICOM CABLE LTD. 244 Newkirk Road Richmond Hill, Ontario L4C 3S5 (416) 884-8151	
EQUIPMENT SUPPLY **TERSTAR ENERGSYSTEMS INC.**	Mr. Ron Chaston General Manager TERSTAR ENERSYSTEMS INC. 504, Iroquois Shore Road Oakville, Ontario L6H 3K4 (416) 893-1947	

NOTES
(1) with Ontario Ministry of Energy
(2) includes TERSTAR (transponder) and LANSTAR

3.4.3 cont'd

TRIAL	NARRATIVE
RICHMOND HILL (ONTARIO) Multi-Utility Service Trial for AMR & DSM	

A two-way Cable Television system is being installed in part of the network to provide Automatic Meter Reading upstream and Load Management downstream.

3.4.4

TRIAL	TECHNOLOGY	TRIAL SIZE
WINNIPEG Interutility AMR Project	TEST TRUNK	100 points[1]
		START Mar. 1992 FINISH ?

UTILITY	CONTACTS	
ELECTRICITY **MANITOBA HYDRO** **WINNIPEG HYDRO**	Ted Cotton Manitoba Hydro PO Box 815 Winnipeg, Manitoba R3C 2P4 (204) 474-3980 (204) 475-9044 (Fax)	Peter Roussin Winnipeg Hydro 223 James Avenue Winnipeg, Manitoba R3B OP1 (204) 986-4600 (204) 942-7804 (Fax)
GAS **CENTRA GAS**	Eileen Devanik Centra Gas 444 St. Mary Avenue Winnipeg, Manitoba R3C 3T7 (204) 934-3343 (204) 934-3838 (Fax)	
WATER **WINNIPEG WATER UTILITY**	Kelly Lyzun City of Winnipeg Water Utility 510 Main Street Winnipeg, Manitoba R3B 3M1 (204) 986-2134 (204) 986-6515 (Fax)	
TELEPHONE **MANITOBA TELEPHONE SYSTEM**	Paul Arsenault, Engineer Manitoba Telephone System Box 6666 8th Floor, 191 Pioneer Avenue Winnipeg, Manitoba R3C 3V6 (204) 941-8754 (204) 943-8762 (Fax)	Al Care Manitoba Telephone System PO Box 6666 12th Floor, 360 Main St. R3C 3V6 (204) 941-8069 (204) 949-9424 (Fax)
EQUIPMENT SUPPLY **SCHLUMBERGER**	Kent Dudley Schlumberger, Winnipeg (204) 786-6147	Schlumberger Head Office Ross Malnie (404) 386-3500 Steve Hughey (404) 446-1991

NOTES

(1) all points are in the City of Winnipeg
approximately 50 points on Manitoba Hydro service
and another 50 on Winnipeg Hydro service

3.4.4 cont'd

TRIAL	NARRATIVE
WINNIPEG Interutility AMR Project	

Installation was completed in February, 1992; delay in obtaining CCAC . . . (for gas and electric meters) had delayed the trial start.

The utilities are testing technology performance in regular, fully loaded, and on-demand reading situations.

In the future, an AMR system would hopefully be able to provide resource management, e.g. "theft and tamper detection", "flow restriction", and "load shedding".

3.4.5

TRIAL	TECHNOLOGY	TRIAL SIZE
CITY OF CALGARY Multi-Utility Service Trial for Electricity & Gas Automatic Meter Reading	TEST TRUNK	80 points
		START June 1991[1] **FINISH** ?

UTILITY	CONTACTS	
ELECTRICITY **CITY OF CALGARY HYDRO DEPARTMENT**	Mr. Chris Morris CITY OF CALGARY P.O. Box 2100 Station M Calgary, Alberta T2P 2M5 (403) 268-1515 (403) 268-5189 (Fax)	
GAS --		
WATER **CITY OF CALGARY ENGINEERING AND ENVIRONMENTAL SERVICES WATERWORKS DEPARTMENT**	Mr. Bob McNeil Department Head Address #34 CITY OF CALGARY 800 McLeod Trail S.E. P.O. Box 2100, Station M Calgary, Alberta, T2P 2M5	
TELEPHONE **ALBERTA GOVERNMENT TELEPHONE**	Mr. Bob Hiew Business Planning Dept, Section 20F Alberta Government Telephone P.O. Box 2041 Edmonton, Alberta T5J 0N5 (403) 493-4059	
EQUIPMENT SUPPLY **SCHLUMBERGER**		

NOTES

(1) three or four months delay occurred in waiting for approval by C.C.A.C. Legal Metrology Department for register/encoder.

3.4.5 cont'd

TRIAL	NARRATIVE
CITY OF CALGARY Multi-Utility Service Trial for Electricity & Gas Automatic Meter Reading	

City of Calgary operate both Electricity and Water undertakings, the trial was therefore more simply co-ordinated and implemented.

Schlumberger supplied the software package and the improved Meter Interface Unit; insufficiently cold weather has prevented low temperature testing however.

Meter reads are performed monthly in the case of electricity, coincident with a meter-reader's visit. The system will allow up to 30-40 reads an hour from one meter.

As with Regina, test-trunk contention was thought a problem for any larger deployment - the trunk being seized sometimes for as long as a week for complicated network diagnosis. Telephone number administration was thought 'cumbersome'.

The feeling was that the Utility Telemetry Trunk ("suppressed-ring") system - when available would, at least partially remove this problem.

No cost information has been obtained.

3.4.6

TRIAL	TECHNOLOGY	TRIAL SIZE
CITY OF REGINA Multi-Utility Service Trial for Automatic Meter Reading	TEST TRUNK	84 point[1]
		START Feb. 1989 **FINISH** Nov. 1991[2]

UTILITY	CONTACTS	
ELECTRICITY **SASKPOWER**	Mr. G.K. REVER Vice President, Transmission & Distribution SASKPOWER 2025 Victoria Avenue REGINA, Sask, S4P 0S1 (306) 566-3070	Ms. Pauline VOSS Assistant to the Vice President SASKPOWER 2025 Victoria Avenue REGINA, Sask., S4P 0S1 (306) 566-2841
GAS **SASKENERGY**	Mr. Brian Torgunrud Senior Engineer, Measured Service SASKENERGY 2221 Cornwall Street P.O. Box 3839 REGINA, Sask., S4P 3R8 (306) 777-9369	
WATER **CITY OF REGINA**	Mr. Randy Garvey City Treasurer CITY OF REGINA P.O. Box 1790 Queen Elizabeth II Court REGINA, Sask. (306) 777-7222	
TELEPHONE **SASKTEL**	Mr. Harry CHOW[3] SASKTEL 2121 Saskatchewan Drive REGINA, Sask. S4P 3Y2 (306) 777-1902 (306) 777-2131 (fax)	
EQUIPMENT SUPPLY **SCHLUMBERGER**		

NOTES

(1) mostly gas, water and electricity

(2) system still in use for Automatic Meter Reading

(3) Mr. Mike Cawood of Sasktel International was project manager initially

3.4.6 cont'd

TRIAL	NARRATIVE
CITY OF REGINA Multi-Utility Service Trial for Automatic Meter Reading	

The utilities have the following customer bases -

Electricity	-	410,000 (2450 MW, peak winter demand)
Gas	-	270,000
Water	-	55,000
Telephone	-	75,000 lines (of which 45,000 are Centrex together with 23 distributed remotes.

A steering committee met frequently to investigate the technology, the economics, reliability and acceptance (by the customer and by the unions).

Project scope was

- 100 locations, nominal
- One Central Office
- mixture of residential customers (including management and employees) and industrial customers
- Gas, Water & Electrical meters were to be installed in residences, with Water only in commercial properties (the water utility were testing different types of meter).
- joint installation programme

Installation commenced in 1989. Schlumberger Ltd. were "very supportive and quick to act" (Mr. K. Rever)

Installation: - initially, 60 residential and 16 commercial sites were installed, Sasktel were most involved financially, providing the Meter Interface Units (MIU), installation and wiring, Utilities provided the meter and encoders.

It was expected that it would take 3½ hours to install the three meter mod. kits, MIU and programming but in some cases it took several times this. In fact to install the 68 locations took eight weeks for a dedicated team. The MIUs were installed on the outside of buildings (to facilitate installation and maintenance (Sasktel was a non-regulated telco, the project was not a service offering). Cold weather (-35°C) hampered installation. Problems were encountered in co-ordinating the attendance of the different utilities.

Technical: Meter Interface Units were failing at -23°C, although Schlumberger replaced them with the improved model 1002, such cold weather has not yet re-occurred (winter 1991-2) to test the performance. The Sangamo Electricity meters too, 'glitched' at -35°C. New Sangamo K2PS electric meters seem adequate.

Contention could occur on the test facility. The telco's automatic loop testing can take as long as a week.

The telephone number administration was a heavy task ("horrendous").
The system was not ISDN compatible and there was not of course, any alarm capability. There was a feeling that "the technology was not yet mature".

Commercial: Initially there was reason to think that agreement could be reached over the costs - that the sum of what the three utilities were prepared to pay per month for reads to the telco, could equal the amount the telco calculated the system would cost (based on a break even period of eight years).

It did not work out as expected (the economics of outbound AMR) and the Regina trial is on hold pending enhancements to the software on phone switches. These will probably not improve the AMR economics. Sasktel is now concentrating on trialing the "ROBI" consumption management technology in Regina with the above utilities (see the SASKATOON trial narrative).

3.4.6 cont'd

An excellent report on the organization of the trial, by Mike Cawood, Manager of Network Services for Sasktel International "Vendor and Product Selection Process" was read at the Automatic Meter Reading Conference, Stone Mountain, GA September 24-27, 1990 and has been included with this present report. (Appendix III)

4. The Canadian Industry Opportunity

4.1 Overview

Canada is ideally situated to implement schemes for Automatic Meter Reading, Performance Monitoring and Demand Side Management, particularly where several types of utility could be involved.

- The penetration of the telephone (98%), of Cable Television (76%) and the increasing use of satellites, all facilitate the introduction of control systems.
- Canada is a centre of excellence in telecommunications research and manufacture.
- Canada is the world's largest user of energy on a per-capita basis. (Figure 1) (48)
- We are solicitous of our environment and have shown world leadership in the introduction of remedial measures - universal energy control could also be one of these.
- There is not a problem as there is in the United States, of a "patchwork quilt" of utility companies; comparatively few utilities (most particularly the telephone) serve large, co-incident areas in Canada.
- Canada is becoming aware of the need to export high technology know-how and products, particularly to continents having similar climates - Europe and the Commonwealth of Independent States (USSR), particularly.

The choice of medium for communication is complex, some guide is given in Figures 9 and 10, 'Choosing a Medium' and 'Functions of Two-Way Communication', taken from an Electric Power Research Institute article.

Overviews of communications choices are contained in references 61 and 62.

4.2.1 Telephony

In all conscience, this should be the medium of choice (even the cable television industry agrees), yet, apart from dedicated leased pairs for monitoring large users, the telephone is hardly used for energy monitoring and control.

The situation is the same in the U.S. Some 2.5 million homes are controlled for load shedding; about 1.5 million use radio, another 1 million use power line carrier but only some few thousand use the telephone network.[2]

Yet, with a penetration of near 100%, the telephone is virtually unused even for conversation - less than some five minutes a day only.

The following seem to be the reasons for the telephone industry's (the telco's) absence from this burgeoning industry -

- the risk; to prove in a telco supported AMR/DSM system as a full service offering requires a massive capital investment. Appendix I, kindly provided by Mr. David Hayes of Schlumberger Canada Limited, gives some idea of the size of a residential deployment equivalent to several millions of dollars. Innumerable trials

[2] There is, however a growing use of the telephone, transparent to the telco, where "call-in" digital dialers using a regular local call, at no extra cost, provide one way and two way communications. There is no interference with regular telephone use. Nertec Design Inc., of Granby, Que. have developed such systems.

have been mounted over the last twenty or thirty years - particularly by Bell Canada and all have proved indecisive in quantifying a business opportunity.

In the U.S.A. a growing number of Public Utility Commissioners are suggesting that they should offer tariff levels which would enable the telcos to make a realistic return on investment - Stephen Brown, (Iowa), Bil Tucker (Wyoming) and John Coleman (New York) are particularly incisive in their thinking on these matters (50, 52, 53).

> Brown - "If the telephone companies succeed in developing a large volume of traffic in their local loop, it's entirely possible that AMR services would be added to that traffic at a low incremental cost. This gives the local telephone exchange companies a competitive edge in the AMR market. How could this edge be exploited?
>
> I believe the first reaction of vendors and the water, electric and gas industries would be to say that there is no competitive advantage; they would strengthen their reliance on radio and power-line carriers as transmission mediums. You might say to yourself that the net result will be no change; the status quo will be maintained, my company can outlast this. But think again. (50)
>
> Imagine a situation in which a Baby Bell,[3] seeking higher profits and opportunity for expansion, becomes a controlling owner of a meter manufacturer. With just a little effort and innovation, by the year 2000 the

[3]A Regional Bell Operating Company or RBOC.

Baby Bell's company could make a device, not necessarily a meter, that measures electric, gas, and water consumption by time of day. Perhaps that device stores the information while waiting for remote interrogation by phone. Maybe the device has some load control capability as well, serving as a relay point for signals between appliances and a district energy control center. Why can't the Baby Bell's company sell the device to the utilities; why wouldn't they buy it? Would the best of all worlds be where the telephone company sells meter-like devices to utilities which then use telephone lines to conduct load management and measure consumption? Just because this hasn't happened in the past, doesn't mean it can't happen in the future. A Baby Bell would definitely have the potential to dominate the AMR market if the company acquired a meter manufacturer." (50)

And, again -

"Given the shortage, our domestic capital markets cannot support a continuing proliferation of business niches in local and statewide communication markets - where electric, gas, water, telephone, CATV, and microwave-wireless tv companies deliver service to and collect information from the same customers. Decision-makers in regulatory agencies, when confronted with a stream of separate requests to approve single-purpose local communication networks, will ask each utility a series of questions: Can scale-economies be achieved by centralizing communication functions over a common path? Is the current diversity of communication paths economically efficient? Have you performed any studies that compare the functions to a common network? Can the local

economy afford the capital investment for all of these single purpose networks? These questions will be asked with increasing frequency because of the country's poor performance on economic growth and because AMR technology has been commercialized much too slowly." (50)

Says Tucker -

"Consider, for example, the charges a utility incurs for meter reading, disconnects and reconnects. Future commissions may ask if remote reading and reconnect are possible. If they are, they will ask what the costs are expected to be and what public benefits are likely to accrue. If the remote reading and reconnect are in the same relative price range as or lower than similar conventional on-site services, a commission might bring the local telecommunications provider into the discussion and planning process. If the new technology could provide better or lower cost service but this was not happening, the public interest would not be served, even though it reasonably could be. A commission faced with this situation might disallow the costs of conventional meter reading and only allow expenses based on the lower costs of the new technology. If local switched network telecommunications company did not provide policies and tariffs which would accommodate this readily available metering service, the regulator might impute metering-relating revenues to such a company. This would be an example -- perhaps a harsh example -- of active regulation providing a strong market-like signal in a regulated environment." (52)

And,

"With respect to the often-heard criticism that "there isn't enough money," it seems strange to me that there wasn't enough money in transporting cable TV for telecommunications providers to upgrade their networks and make some good money in the process, especially since there was enough money in it for the cable television industry to build a very extensive and very redundant parallel physical plant across much of America. This is an utter failure of the system, for the regulators and the utilities, which I don't believe should be further prolonged and, encouraged or tolerated. It unnecessarily costs the Americans a good deal of money which they could spend more effectively and efficiently elsewhere." (51)

"Again it is said that current legislation inhibits the telcos' entering the market, the problems of ownership of meter interface units and customer premises equipment making for an insecure future. In this regard, at least one Rates Council (New Jersey) has disallowed a telco's attempts to recover AMR equipment costs within the rates" (54)

"The AMR industry will be significantly affected by the July 25th, 1991 decision of Harold Greene, the U.S. District Judge in Washington D.C. He gave the nation's seven regional telephone companies, the so-called Baby Bells, permission to sell information over the companies' own telephone lines. There's no limit to the kinds of information that can be sold: Home shopping,

home banking, stock quotes, classified advertising, electronic Yellow Pages, and anything else you can think of. If the telephone companies succeed in developing a large volume of traffic in their local loop, it's entirely possible that AMR services would be added to that traffic at a low incremental cost. This gives the local telephone exchange companies a competitive edge in the AMR market. How could this edge be exploited?" (50)

The utilities have an ingrained fear and distrust of the telcos. They feel that any changes and tariffs implemented will be progressively escalated to the point where any project becomes economically unviable.

They feel that installation charges are unjustifiably high. Coleman (ibid) refers to the following:

"A second ruling related NYT occurred in 1987. The New York Telephone Company tariff requires that any connection of customer-premises equipment to its network occur at a company provided interface (modular jack). New York Telephone's charge for the installation of a single interface was approximately $47 for residence and $85 for business. Staff found that if utilities seeking to use the telephone network for AMR had to pay these costs the economic effectiveness would be questionable. To that end, Staff recommended that the Commission directed NYT to install interface jack on a trial basis for $10 apiece so that Spring Valley and National Fuel Gas

Distribution Corporation could expand their AMR trials. The Commission approved this recommendation in May of 1987." (53)

The writer has sensed the animosity; a non-telco systems manufacturer who has stated that his company entered the industry with their technology because "the utilities don't like the telcos." Again we found it impossible for one utility to sit with the telco at an exploratory meeting in the latter's premises.

Finally, even in a trials deployment the telco can adopt a recalcitrant attitude. The Director of Municipal Services, Mannassas, VA., stated at the 3rd AMRA Conference, Stonemountain GA. in September, 1990:

"..... we had substantial problems with the attitude of the telco ..... not at the working level but with senior staff ..... they treated the trial as a mature technology, wanted it to subsidize their rate of return and <u>were totally unco-operative at a corporate level</u> ..... would not even supply telephone numbers ....."

Finally, the telephone industry feels that it does not have, and is fundamentally incapable of providing the technology.

It has become almost folklore that the telephone cannot be used in a broadcast mode, the fundamental step-by-step sequential switching within a Central Office being incompatible with the need for 'mass addressability'.

Certainly the electrical utilities, who have a prime need for energy curtailment at peak demand periods by the periodic removal of non-essential appliances for periods of time believe it, and the telcos themselves appreciate this.

Yet it can be done. An entire telephone technology could be built on the quantifying of a single parameter - how many homes have to be addressed in unit time? Certainly Bellcore agree (during a discussion during a presentation at the recent 'Partners or Rivals in the Local Loop' conference). No electrical utility seems able to supply a figure, times varying from 'near instantaneously' to '50,000 water heaters in a minute - or even five minutes. Even a grouping - say four to five thousand homes on a utility feeder could be acceptable.

Mr. Michael Maher of the Potomac Electric Power Company (PEPCO) says "100,000 cut off in five minutes by the telco? We'd take it" He went to say (at AMRA'91) "C&P telephone for years would not tariff no-ring service - they said they couldn't do it so PEPCo started to use digital dialers upstream." And, incidentally radios downstream; 100,000 on air-conditioners and 40,000 on water heaters.

Some radio and power-line-carrier systems use a broadcast mode with, in the home, time delays which reinstate power after preset, staggered times. Repeated broadcast signals are transmitted to maintain the 'off' condition - the fear being that failure to receive a broadcast 'on' signal could result in permanent removal of power from appliances and would antagonise customers - a sad commentary on the distrust of the technology.

Certainly the replacement of power requires some time demultiplexing in order to avoid the shock to the electrical network of a 'cold load pick-up'.

Even if simultaneity were required, it could be achieved by using longitudinal signalling techniques. Terraplexer Corporation of America (a new entrant, albeit with successful trials) say that their system "Reads up to 4,000,000 meters in 32 seconds, every 32 seconds."

Another U.S. company offered its 'Mercury' system, (based on New York Telephone work) but abandoned it later, due to a lack of perceived demand at that time.

The new Utility Communications Architecture, developed by the Electric Power Research Institute, Pacific Gas and Electric and Houston Lighting and Power, provides no solution.

It has to be hoped that the new Utility Telemetry Trunk, standards for which are being developed by the Regional Bell Operating Companies, with AT&T, Northern Telecom &

Siemens, could at least offer a partial solution to the problem - but members are doubtful. Also doubtful is the ability of the much vaunted Integrated Service Digital Network (ISDN) to solve the problem, even if it were to be deployed domestically - itself doubtful. (56, 57) Bellcore point out the pitfalls of attempting to introduce analog devices with a digital ISDN deployment (58). The 'D' Channel could perhaps be used in a pseudo way.

Cynically, as Dr. R.A. Peddie, the U.K. expert (and introducer of the CALMU, Credit and Load Management Unit System) said in correspondence with the writer – "despite expressions of interest by the PTTs around the world in new business, I have yet to meet a PTT who is willing to take communications with a communicating customer's electronic terminal seriously."

There is a business opportunity here, however. As Dr. D.L. Schlenger says - "will a single utility read all the meters as a turnkey service for the other?" (60)

Great initiative is being shown by the joint AMRA/IEEE Standards Co-ordination Committee 31, where Mr. David Whelan, Chairman of a sub-committee, has been responsible for the issuing of a questionnaire to utilities asking the specific question of at what speed do residences have to be accessed for energy reduction and replacement? Results are expected by the end of May 1992.

The last word - and increasingly, the Public Utility Commissions <u>are</u> having the last word; Commissioner Bil Tucker postulates -

"How will automatic meter reading programs affect or be affected by other utility services? Some meter reading programs operate over wire lines and require digital central telephone offices to work effectively. Many central offices in both independent and Bell-related telephone companies do not have the necessary digital equipment installed. However, cooperation between telephone companies and the other utilities and innovative rate design for meter reading and related services may result in benefits to both telephone customers and also for the customers of gas, electric, and water utilities. For example, assume that a gas company's automatic meter reading program calls for a telephone monitoring and reporting system, but the local telephone company does not have a digital switch. Coordination between the two utilities working with the state regulatory commission could result in the installation of a new digital switch. The switch would enhance service to telephone customers, yet some of its costs would be borne by the gas company through the local access charges. If this system were designed and costed properly, the results would be new services and options for telephone customers and lower gas utility costs provided by automatic metering." (52)

4.2.2 Radio

This is the ideal by-pass medium, the utilities think. Comparatively cheap to deploy, no recurring and escalating tariffs to be paid to the telco, reliability of service all entirely under their control, true, instantaneous multi-addressing, it all seems infinitely attractive.

The problem, and it's insoluble, is the limited availability of radio bandwidth.

Mr. Charles M. "Mike" Meehan, the Executive Director of the Utilities Telecommunications Council (131) remembered that in the 1970s the utilities communications systems were based on the telephone, but that it was "killed by the telcos", over who was going to manage the network.

Unfortunately there was very little unused bandwidth and what was available is now progressively being denied by the FCC. The wholesale sequestration of the 928-952 MHz band could cost the utilities some $2 billion to replace. Eul Wade of the Southern Company suggests that it could cost his company some $20 to $40 million alone. The 120 and 220 MHz bands have been denied to radio amateurs and television channels 70 to 83 have been removed. The FCC are even completing a technical study for clearing the 1850 - 2200 MHz band. All this to aid the new Private Communications Network (PCN) industry, itself expected to become a $40 billion market. The re-allocations are therefore thought to be inevitable.

As Professor Negraponte of MIT points out - "everything we send over wires will be sent over the air in ten year's time, and everything that we send over the air now, will be sent by wire."

Or by fibre. The author's view is that fibre, eventually, will be virtually the sole, ubiquitous, communications medium. That is why it is essential that the utilities deploy fibre

now, as part of their expansion and upgrading programs - hopefully in happy partnership with the telephone industry.

Again, Mr. Meehan - "Is there some way that we can get into the act with fibre? We're ringed with it".

The scarcity of private radio spectrum has caused many Federal Regulators, including the Federal Communications Commission (FCC) to alter their traditional regulatory thinking. The FCC is beginning to reject the historical "radio service" or "pool" approach to allocations and, instead has begun to espouse the view that radio spectrum should be treated as a commodity resource, similar to oil or minerals. As such, it should be distributed through some form of marketplace mechanism.

Certainly a committee of the Utilities' Telecommunications Council is investigating it.

The situation is so desperate that the FCC has started to allocate frequencies by lottery. In October 1991 they offered some frequencies in the 900 MHz band in this way; there were some forty to fifty thousand applicants each paying between $20 to $30,000, to register.

In May, allocations were offered in the same way, for fifteen radio channels providing roughly a forty mile radius, for local use. There were 65,000 applications on the first day, each with a $49,000 filing fee.

The UTC filed recently for a 10 to 15 channel, nation wide land-mobile trunk system - they believe the odds of their winning will be one in six or seven.

This frenzy resulted in an excellent lead article in the New York Times recently (64) in which it states, *inter alia*

"No one has ever doubted that a license to use particular radio frequencies has enormous value. But even some F.C.C. officials were stunned last month by the frenzy that erupted over a small sliver of the spectrum being made available for new mobile communications services. At stake are licenses to 200 tiny radio channels, which together use bandwidth totalling 2 megahertz. That is about 4 percent of the bandwidth used by cellular telephone services and about one-third the bandwidth of a television station. Designated primarily for private communications services, such as those that link fleets of trucks and cars, the new channels are designed to exploit new technologies for transmitting both voice and data over very narrow frequency bands. Despite the small size of the channels and the fact that the F.C.C. has not approved the equipment to be used in such services, the agency was deluged. It received 46,000 applications on May 1, the first day applications could be submitted. When the total surged to roughly 100,000 after three weeks, the agency stopped taking applications. Why the allure? Advances in digital transmission allow mobile voice communications comparable to cellular phones at potentially lower prices. Also, private radio networks can now relay calls to

public telephone systems, making it possible for users to call virtually anyone. Data services will also be possible. F.C.C. officials say the flood would represent a six-month workload if the entire private radio bureau licensing division were assigned to the job. The first licenses are not expected to be awarded until late this year." Figure 8 shows how new services are "vying for space on the spectrum."

Whilst this situation is most unlikely to occur in Canada, with our large area and comparatively low population density , it is to be hoped that the corresponding body - the Canadian Radio-Television and Telecommunications Commission, will adopt a more structured and long-term solution to the problem.

Certainly useful radio technologies are being developed in Canada - Iris Systems are testing a system in Winnipeg using miniature SHF transmitters incorporated in electricity meters for automatic meter reading - soon to be followed by similar receivers for load shedding (65).

This company has gone further (66) and stated, in a recent press release –

Minneapolis, MN : Iris Systems Inc. announced today that Northern States Power, Minnesota's largest electric and gas utility with 1.677 million meters, has awarded Iris Systems Inc. the industry's first all radio, automatic meter

reading (AMR) trial for electric, gas and water meters. The trial will use Iris' patented System 2020™ technology.

Northern States Power selected Systems 2020™ "because the innovative architecture provides customer information at a reasonable cost", said Ms. Wanda Reder, Northern States' Communication Project Manager. Iris' ability to cost effectively support current as well as future needs was a major factor in the selection. Key features of System 2020™ include:

- 100% radio approach. Eliminates residential wiring. Makes gas, water and electric AMR viable.
- FCC licensed radio communications. Provides permanent access to an assigned channel. Secures operation of the AMR investment.
- Cost effective communication backbone. 10-100 times less expensive than competing products.
- Functional system - supports information needs of various departments ...Billing, Marketing, Maintenance, Finance, Rates, Engineering.
- Field proven operation results since 1989.
- Figure 3 illustrates the system.

It should be pointed out that problems may occur if meters are screened. Foil wallpaper, chicken mesh and stucco, aluminum siding (although satisfactory if windowed) and 'Ultrawall' products (using metal studs) have all been known to cause difficulties. (67,68)

One solution is to use an externally mounted transmitter (and receiver) even on the local feeder transformer and then to hard-wire - or use power-line carrier from there on. Metricom use this latter system satisfactorily in the United States, useful in California where a significant proportion of the customers live in aluminum homes - and in canyons.

A good and very new example of this hybrid solution - radio and power-line-carrier, is the General Electric Advanced Metering System (UCNet) - actually a joint venture between GE Meter & Control and Ericsson GE Mobile Communications. (Figure 12) Importantly, UCNet has been planned around UCA and CEBus public protocols and uses a Digital Access Communications System (DACS™) which increases the capacity and speed of the radio system. Metering data security is ensured by an authentication and encryption system developed by GE's CR&D cryptography experts. Trials are currently being carried out in Somersworth NH and Lynchburg VA.

Finally, two more enterprising Canadian companies who should have more applications in our industry must be mentioned -

Mobile Computing Corporation of Unionville, Ont., have developed mobile data networks for many disparate industries, including waste disposal and metered liquid delivery markets - two more types of utility that we should perhaps, integrate into our Multi-Utility Telemetry Systems.

Telesystems SLW Inc., of Don Mills, Ont., offer systems for commercial wireless data networking based on spread spectrum radio technology. Their 'ARLAN' product is the first to be certified by the FCC under part 15 in the U.S.A. and D.O.C. type accepted in Canada for sale without a radio license. Again this is a type of system worthy of consideration by utilities' system planners.

Telesystems, and several US. companies have introduced spread-spectrum technologies into their 902-928 MHz radio products (94).

4.2.3 Cable Television

CATV remains basically a one-way, downstream medium, although newer systems are being built and "fitted for, but not with", upstream amplifiers. By this is meant that the downstream amplifier enclosures have space, backplanes and connectors for the later provision of an upstream capability (86,87,88).

Coaxial connectors too, are of a higher quality and the outer screen of the co-axial cable is often now a continuous conducting tube, rather than the old open-weave copper braid. These precautions are to prevent the egress and worse, the ingress of noise and RF energy which can bury any upstream signal.[4]

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[4] Yet Terstar Enersystems Inc.,of Oakville, Ont., who have developed a Central Energy Management and Control (CEMAC) system using two-way cable television, and which is currently being trialled have found that "upstream noise has not been a problem; indeed action we were prepared to take to counter up-stream noise have not had to be used". Ontario Hydro and the Ontario Ministry of Energy are supervising the trial.

Videotron Ltée of Montréal, Quebec, has shown great initiative in providing a two-way cable television system as part of its Video way interactive television system (85) .

By careful attention to amplifier linearity, choice of carrier frequency and physical quality of the network, bit error rates in an upstream direction of less than 1×10^{4} for 98% of the time or 1×10^{6} for 29% of the time are obtained. A speed of 500 kbps is achieved for digital transmission using minimum shift keying (MSK) at 26MHz.

Signalling downstream over the CATV network is comparatively straight-forward, a most common method being to transmit signals in the Vertical Blanking Interval (VBI) that is, the space between successive frames. Signals can either be broadcast or addressed to individual or groups of subscribers. (89)

However, the penetration of cable television, and in particular two-way cable remains, possibly too low to provide a sufficiently ubiquitous service to the utilities.[5]

4.2.4 Power Line Carrier

Within the context of a multi-utility service trial, or full deployment, power line carrier provides an excellent link in accessing a meter or controlling a load in the residential environment. The West Penn Power Company report excellent performance from their Two

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[5]In Canada, by the end of 1991, cable television passed 94.4% of homes licensed; 76.4% of the subscribers in the licensed areas. (CCTA, Mediastats)

Way Automatic Communication System®, manufactured by Chance Load Management Systems (77). Ontario Hydro, too, have tested the TWACS System in a recent trial.

Increasingly and as explained in section 4.2.2, Utilities are considering the use of hybrid systems - radio to and from the feeder transformer and power line carrier from there to and from houses. (Figure 12) (74, 75, 76)

Typically, in North America there are a dozen homes to the transformer, and the sharing of the power circuit involves no real problems. It is interesting that in Europe the situation is not so simple, the lower power consumptions, at half our currents, can result in as many as sixty homes sharing the transformer, with consequently more interference problems.

The power line carrier system being increasingly adopted in the home and thence to the pole is the Consumer Electronics Bus (CEBus) developed by the Electronic Industries Association. (105) It represents six years work by some sixty consumer electronics companies and consultants - yet it still has to be sealed and issued. Other standards will shortly be issued defining the use of twisted pair, infra-red, co-axial cable and fibre-optics. (39,95)

One problem faced last year by the CEBus Power Line Group was an awareness of the remorseless increase in mains-borne noise which was resulting in less than acceptable bit-error-rates when using Amplitude Shift Keying.

A new spread-spectrum modulation technique has now been adopted (being developed by Intellon Inc.) (137) which is expected to secure the system from these worsening noise levels. Several companies are now already offering spread spectrum systems (46, 69, 47) under the aegis of the FCC. (93)

The existing devices used for power line communication is the X1O product range developed by BSR and also marketed by Leviton, Tandy, CyberLYNX and others.

It is interesting to compare a summary of the standards (76).

	X1O	CEBus
Data Rate	60 bps	10 kbps
Carrier Frequency	120 KMz	100-400 KHz
Type of Modulation	ASK	Spread Spectrum
Sensitivity to narrow band impairments	High	Low
Dynamic Range	40dB	60dB
Signal level on power line	8v p-p	5v p-p
Two way operation	No	Yes
Broadband receiver	Yes	Yes
Arbitration protocol	No	Yes
Ownership	Proprietary	Public

It should be borne in mind that there are now several secondary side PLC modems, and not all CEBus -

Manufacturer	Protocol
Intellon	CEBus
ICSS	CEBus
Adaptive Networks	CEBus
NEC	Non-CEBus
Honeywell	
Echelon	Non-CEBus
Metricom	
Schlumberger	

The Electrical Environment

The rising tide of electrical noise, particularly in the residential environment, is becoming a major concern in our industry - and not just noise; the physical distortion of the electrical utilities pristine sine-wave is even causing them to worry.[6] Further than that, residential power circuit impedance varies wildly with frequency and with time. It is an environment which is worsening continually and which has never been comprehensively researched. It is known that Georgia Tech has undertaken contract research for the Smarthouse Limited Partnership and Mr. Don Pezzolo of Diablo Research Corporation has directed his company in some excellent research (142).

(a) Noise particularly narrow-band impairment, is increasing. Switches produce transient electrical noise, the undesirable effects of which vary from "trifling annoyance to catastrophic malfunction and failure" (79).

1) Solid-state devices are notoriously non-linear, and the increasing use of thyristor incandescent lamp controls is growing. Thyristor control is now being applied to heavy current oven controls and variable speed air-conditioning motors - although in the latter, the interposing of a supply transformer gives a degree of isolation. Fluorescent lamp electronic ballasts and even the tube discharge itself, generate noise.

2) A new and ominous source of noise are the new miniature electronic ballasted fluorescent lamps, designed as an incandescent lamp replacement and to economise in electricity consumption. One design has operating figures of 18 watts - or 27VA. It has been measured to have a total harmonic distortion of 112% (!). Worse, such devices can jump, at random, from a comparatively quiet mode to a noise generating condition.

3) Of greatest concern to PLC modem designers are mains-borne baby monitors which use a simple amplitude modulation system with consequent transmitted interference. There use is growing and irreversible. Several

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[6] Harmonic pollution is rising in electrical supply, with two detrimental effects; customers are being charged for something that they cannot fully use, and the pollution can damage equipment and cause maloperation on computers. (96)

susceptibility test have been performed and are referred to in this report (80, 90, 91).

4) Even coupling units, designed to prevent the egress of mains-borne RF - say from television receivers themselves, induce undesired modulations (92).

5) Switching power supplies, increasingly used in small and personal computers operate non-linearly and induce noise.

(b) Waveform Distortion Other power lines carrier systems can themselves introduce distortion. The TWACS (Two Way Automatic Communication System) technology operates by modifying the voltage waveform (and the current waveform, if two-way communications is required) by short-circuiting the circuit for a few milli-seconds at the zero cross-over.

An elegant solution, which enables communication (albeit slowly) over the entire power network, without any alteration due to transformers, on-load lap changers, or capacitive power-factor correctors.

A problem could be the noise generated due to this waveform discontinuity, although Ontario Hydro, who have tested the TWACS system with great success, have not discerned any interference.

An excellent report on the introduction of the TWACS system in a combined electricity, gas and water meter reading system is that prepared by West Penn Power Company. (77)

(c) Impedance Variation The characteristics of the Power Line Carrier channel are essentially controlled by the products plugged into the power line and whether or not the product is turned on. The impedance varies alarmingly with frequency and arbitrarily with time.

Mr. Pezzolo shows varying impedance and attenuation plots over the range 10KHz to 600KHz and impedance load alterations over the same range for a television receiver, a videocassette recorder and a miniature fluorescent lightbulb (78).

The use of Power Line Carrier has grown out of expediency - because the power conductors were there, immured in walls and available. With worsening

noise and a restriction in bandwidth it will never be a permanent solution - as fibre will.

4.2.5 Fibre Optic Distribution Systems

Again, the use of fibre is seen as too expensive, too labour intensive at installation and too far away in time to be considered - hardly in the local loop, let alone the house.

Yet there is a trickling-down effect. The use of fibre optic technologies by the telephone industry for long haul, multichannel trunk use has now resulted in an industry where it is now considered the norm to provide fibre in the riser, for high rise offices, and to test fibre in many "fibre to the home" trials. (63,99,113,114)

The problem with fibre, almost, is its sheer lavishness of bandwidth. The laws of physics limit the bandwidth of fibre to about fifty Terabits/second (fifty million-million). Consider that Automatic Meter Reading could be adequately performed at, say 500 bit/second then we have a medium which is one hundred thousand million times wider than it need be. But of course, by multiplexing, myriad of channels could be carried.

A complete cable television system (at 500 MHz, eighty separate stations) could be carried one hundred thousand times over.

Fortunately (almost), present electro-optic technology limits the bandwidth that can be used to about 5Gb/s (five thousand million bits/second). The point is that fibre, generally deployed, will allow virtually limitless capability for data, voice, television, high definition television and other applications undreamed of, for generations to come.

That is why the Public Utility Commissioners and other far sighted commentators are promoting the deployment of fibre, now.[7]

Papers by Steve Rivkin "White Knights For Fibre Nets. Now Electrics Can Help Telcos Build Fibre to the Home: (99), Eric Ackerman "An Electric Utility Perspective on Fibre Optics in the Local Loop" (100) and Steve Brown "Financing Electric (& Other) Utilities' Shares in Local Loop Fibre Networks: Economic and Political Considerations" (49) all point out the symbiosis of the electrical utilities needs (& opportunities) and fibre's promise.

"Ironies abound; at the residence, the telco needs power precisely at the point where the utility needs data - near the residential electric meter[8] (99). Also in powering fibre pedestals, (the box in the street from which the fibre fans) the telco plans to "bypass" the power company to get electricity; even while the power company is contemplating its own "bypass" of the telco (by radio and power line carrier) to get data for distribution automation" (Rivkin)

It has been said that the telcos have only two real problems in deploying fibre in the local loop (that is, to the home) - they can't power it and they can't pay for it. Both problems are now seeking solutions that play to the utilities expertise and resources. (103)

> "....we are also encouraging our members to consider non-spectrum (radio) dependant systems, including utility owned fibre CATV and telephone" says M. Meehan, Executive Director of the Edison Electric Institute, at last year's EPRI Conference. (131)

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[7] "At least thirty-two telco fiber loops are in test demonstrations in the U.S., with not one directed toward electric utility demand-side management. That omission should be .....remedied". (99)

[8] Fibre systems don't use electricity. They use light. So wherever physical work must be done to operate the fibre system, electricity must be separately and locally provided.

"This country needs economic growth and revamped human capital. Local communication needs and services are splintered into tiny pieces where electric, gas, water, telephone, CATV, and microwave-wireless tv companies are delivering "innovative" services to and collecting information from the same consumers. This diversity is not economically efficient. Growth of business niches in local and statewide communication markets are signs of foregone scale economies and near-duplication of physical plant. Now is the opportune time to reverse these trends by forming partnerships that bring fiber to the local loop'. (49)

The non-electric utilities could be involved, too. Burying any service is labour intensive. The writer as a consultant advises any district heating project, being planned, to include at last one fibre cable with their distribution network for cost effectiveness. They can lease it out, later.

An interesting commentary on all this concerns the closure of the Winnipeg District Heating System in 1989. (101) It is understood that the system was leased by a bypass telephone company who are now stringing cables, including fibre, in the tunnels.

This is a major business opportunity for all utilities (particularly the electric) to work co-operatively with the telcos to open enormous, and growingly enormous, services. Figure 11 shows the cost reductions and fiber penetration expected in the U.S.A. (114)

A final thought; Stephen Brown in his excellent politico-economic paper, refers to a report -

"Japan's Nippon Telegraph & Telephone Corporation has announced that it intends to invest $12 billion to install a national fibre optic network which would reach every home, office and factory in Japan by the year 2015 (49)."

The writer calculates that to do the same in the USA and in the same time frame would cost $100 a year for each householder - surely an achievable target?[9] It would pay the Japanese to offer to perform the work - they could then put on the ends their entertainment products, of a complexity and sophistication undreamt of - and keep their consumer products industries operating at capacity for generations.

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[9] One market research company predicted that by the year 2001, more than 40 million homes will be connected to a nationwide fibre-optic network. (114)

5. STANDARDS

5.1 The Necessity for Standards

Like most new and proliferating technologies, the industry is bedeviled by very many existing and proposed standards for communications protocols, nearly all of which have some relevance in the Multi-Utility Automatic Meter Reading & Demand Side Management field. (1,2,3,4,6,36 and 121)

The Intelligent Building Institute's consultant, Dr. Kenneth Wacks, has identified some thirty-six such standards, at least twelve of which are relevant to the Institute's work of adopting, adapting, or introducing a standard for their industry. (4)

These many standards are listed in Appendix VI.

In December 1990, the Electric Power Research Institute held a workshop to discover why advanced metering technologies were not being fully exploited by utilities. Overwhelmingly it was agreed that the lack of protocol standards was the largest problem area limiting system implementation. (24) - see Figures 13 and 14

Fortunately, determined efforts are now being made to rationalise these standards and encourage inter-operability.

5.2 The Work of the Legal Metrology Department, C.C.A.C.

The Consumer and Corporate Affairs Canada's Legal Metrology Department have, since May 1990, been convening meetings of a Task Force on Standard Data Communications Protocol for Electronic Metering Devices.

The Task Force is:

- To examine the existing data communications protocols, data formats, and hardware interfaces for microprocessor based devices.

- Either to adopt one of the existing data communication protocols, or mixture of protocols, as a singular standard, or to develop a complete new data protocol for electronic metering devices.
- To report on its deliberations and discussions to the Metering Section of the Canadian Electrical Association and the Measurements Committee of the Canadian Gas Association.

The Task force comprises the representatives of meter manufactures, utilities and the CCAC. The members of record as of September 10, 1991 are as listed in Appendix VI.

After analysing some dozen applications of a hypothetical protocol, (17) from meter reading through tie line and generator monitoring to load control and profiling, some ten tariff and user groups were defined -

- Residential
- Commercial
- Industrial
- Load Study
- Time of Use
- Load Management
- Quality
- Customers on Interruptible Tariffs
- Interconnections
- Generating Plants

There are a variety of communication channels, or links, that can be used, and they are:

- Direct, that is, Local
  - One on One
  - Polled Multi-Drop
- Remote

- Direct Digit Dialing
- Two and Four Wire Leased Lines
- Packet Radio
- Fiber Optic
- Power Line Carrier
- FM Radio

Eighty combinations - many more if one considers the sub-sets of Power Line Carrier, of Telephony, and of Radio.

The Task Force decided (like the U.S. Accredited Standards Committee, C12.17 for Meter Data Protocols) to satisfy all combinations - "all applications, all media". Interestingly the International Electrotechnical Commission's Work Group 14, (Data Exchange for Metering) of Technical Committee 13 (Metering) (10,11) have elected to confine themselves to just three pairs of combinations -

- Direct, One on One
- Direct, Polled Multi-Drop, and
- Remote, Distribution Line Carrier.

The Task Force created a model of the kind of protocol that they were looking for, prepared by Richard Tucker (Duke Power) Kah-Fae Chan (Toronto Hydro), Jean Joly (Quebec Hydro) and Glenn Allen (Ontario Hydro) (reference 23). This is at present in the comment and revision phase. (20,5)

5.3 Standards Review

At the Task Force meeting on December 11, 1991, the Legal Metrology Department's Data Protocol Working Group presented information on some dozen relevant protocols. Their question was really - should we adopt, adapt or add another?

5.3.1 ANSI C12.19-xx

A proposed draft American National Standard for solid state data recorders for electricity metering, issued in June 1986. Despite the acclamation with which it was received, it was never adopted. There is still hope that it will be. (9)

5.3.2 UCA (EPRI 2949-1)

The Utilities Communications Architecture, developed by the Electric Power Research Institute with Pacific Gas and Electric and Houston Light and Power, has recently been completed in Volumes I through VI. The first volume is only available to initial participants, and only volumes IV and VI will be released. (27,28 and 29)

EPRI identified some 36 protocols being used for data communications within the electrical utility industry (the gas industry have some of their own, see below) and hope to reduce the number to four, even two. Ninety three standards are referenced. (71)

It is encouraging to learn that the UCA standard is already being adopted, notably by the Automatic Meter Reading Association. (25, 26 and 31)

Authorities in the gas industry feel that they should adopt it, too, with some slight changes. "After all EPRI paid $5 million to produce it."

Sadly though, as the "DA/DSM Monitor" says, "The distribution system project engineer still has little hope of compatible products or systems in the foreseeable future, despite the widely publicized Utility Communications Architecture (UCA) announcements made by EPRI in July and August. The fragmented industry created, in part, by the large 'clout' of such a small number of independent thinking utilities means few *de facto* communications standards exist. The overhead this creates, such as the need for convertors, translators, and software maintenance, add both initial and ongoing costs to already stretched distribution budgets". (30) Reference (146) in its entirety is an important source on UCA.

As Carolyn Kinsman pointed out in her critical paper, read at the recent DA/DSM conference, many of the services offered by US telcos are not available in Canada, with the result that Canadian Utilities will not be able to implement many of the UCA features. (129)

5.3.3 ADEPT V3.0

Has been developed for the gas industry by Nova Corporation of Alberta, approved by the American Gas Association and placed in the public domain. Patterned on the OSI reference model, it has the capability for carrying other protocols.

A communication from Mr. M. Reid of Nova and a member of the Task Force provides a most useful analysis of gas requirement similarities and differences from those of the electrical industry (138)

5.3.4 DP50/Fieldbus

Fieldbus is a new, worldwide communications standard which specifies messaging protocols for all digital communications among field devices and control room services. The Fieldbus standard is being specified by a joint effort of the Instrument Society of America (I.S.A.) and the International Electrotechnical Commission. Its application will be in the process control industry and is analogous to a similar MAP (Manufacturing Automatic Protocol) introduced into the manufacturing industry.

No consideration has been given to a gateway to other systems yet. (8)

There is an active International Fieldbus Consortium which last met in Salt Lake City in June 1991. (32, 33)

5.3.5 BACnet

In January 1987, The ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers) Standards Committee formed a Standards Project Committee (SPC-135P) to "deliberate the creation of a communication protocol that will become an industry

standard". The name chosen for this protocol was "BACnet - A Data Communications Protocol for Building Automation and Control Networks". (7,34,35)

Current plans called for a public review draft of BACnet to be available in the spring of 1991. "However, if changes are required, additional public reviews might be necessary, delaying final publication by an uncertain amount". (42)

The draft is still under review at the date of this report (March 31, 1992).

5.3.6 PPP

Point-to-Point Protocol, developed to provide a High Level Data Link Control for Computer data access. There is a Network Working Group who have issued a Request for Comment, RFC1171.

5.3.7 CEBus

The Consumer Electronic Bus Committee, formed under the aegis of the Electronic Industries Association (U.S.) has, after six years hard work by representatives of some sixty companies produced the CEBus proposed interim standard for Home Automation System protocols using power line carrier - within the home. (12,13,14,15,16 and 73)

This standard is long needed and has great potential. (72) Already demonstration homes have been installed with CEBus systems - most notably the "Bright Home" installed by Hometronics Inc , under the sponsorship of Indiana Light and Power and Public Service of Indiana. (40) CyberLYNX Computer Products Inc. have taken work further and have developed an energy management system, coupling the Integrated Services Digital Network wide area, and Consumer Electronics Bus local area networks by means of a residential Gateway. (37, 38) Apart from sponsorship by the Energy Management, Metering and Automation Technical Alliance, the University of Colorado and industry, Duke Power has involved its Columbia Project in this "Smart Home" Project.

Société Microelectronic Industrielle de Sherbrooke have submitted comments on the CEBus specification and its application in Canada. (21,22)

One problem for the CEBus Power Line Carrier system is the extremely high level of noise on residential circuits which has resulted in the decision to adopt spread spectrum modulation techniques. Intellon Inc., is developing the technology. (137)

5.3.8 ECHELON (69,70)

The Echelon Corporation was founded in 1988 in Palo Alto, California by Mr. A.C. Markkula (co-founder and vice-chairman of Apple Computer Corporation) and Dr. M. Kenneth Oshman (co-founder and former president of Rohm Corporation). There has been an impressive investment,[10] with Motorola and Toshiba providing products. 'Lonworks' 'Lonbuilder', 'Neuron' and 'Chips' are all registered or trademarked as their products.

Lontalk is the communications protocol which uses a Neuron family of intelligent distributed control processors - transceivers, routers and network managers.

The system, protocol and OEM products are seen as the method if implementing control systems - residential, commercial, industrial and manufacturing.

A massive promotional campaign - in North America, Europe and Japan, backed with the readily availability of Lonbuilder Development Systems and product chips seems likely to re-direct several national communication projects.

Products of interest in the Meter Reading area include -

- **Power Line Transceiver**
  - 9600 BPS operation

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[10] "LONEWS" (February/March 1992) states that Motorola, Inc., will invest $20 million, alone.

- Works in the presence of power line intercoms, switching supplies, dimmers, electric motors and other common impairments
- FCC approved
- Low cost IC under development
  - IC will operate from -45° to +85°C
  - IC meets world wide emissions requirements
  - FCC(US), Centelec (Europe), MPT (Japan)

- **RF Transceiver**
  - 4800 BPS operation
  - 49 MHz, FCC approved
  - Small PC board loop antenna
  - Very low power standby mode ((10μA
- **Twisted Pair**
  - RS-485 with industry standard driver
    - Inexpensive, wide temperature range
  - 78 KBPS & 1.25 MBPS transformer coupled designs
    - ±250V isolation
    - Greater distance, more nodes/link
    - Optional collision detection for high performance
    - Optional link power for installation ease
- **Utility applications are seen to be -**
  - Remote meter reading
  - Load shedding
  - Distribution monitoring & fault detection
    - Electric
    - Gas
    - Water

  Customer information
    - Rate structures
    - Time of use

- Types of appliances
- WAN services

The Echelon system introduction needs to be taken very seriously by any utility considering the introduction of residential - or industrial Automatic Meter Reading or Demand Side Management projects. (41)

5.3.9 Adaptive Networks

Adaptive Networks Incorporated was formed in 1983 to design and market a sophisticated spread spectrum power line carrier communications system.

Early customers included shipping companies, who can now monitor temperature and humidity in refrigerated containers, in supermarkets, for rapidly-changing point-of-sale information and in security access systems.

So impressive is their technology that it was voted an International Standards Association international standard DIS 10368 in January 30, over such competing systems as the Westinghouse narrowband system and the NEC (Japan) spread spectrum system. It did not, however become the CEBus standard where, in December 1990, a decision was made to adopt the Intellon Inc. technology. (43, 44, 45 and 46)

The performance is high. With a raw data rate of 150,000 bps and an effective throughput of 19,200 bps, a bit error rate of 1 in 10^9 is achieved. A range of up to 4 km phase to phase is achievable.

No licencing fees are required.

5.3.10 **IC/SS**

Another power line communication system, and only recently introduced (September 1991). Developed by Cypiex Inc. and Itron Inc., the products are manufactured and marketed by National Semi-Conductor Corporation.

Spread spectrum techniques are again used, over a frequency range of 20 and 90 KHz.

Reliable communication over the power distribution system at data rates of up to 3200 bps are achieved, with future generations expected to communicate at up to 9600 bps or higher.

Products are designed to meet FCC Class A and European CENELEC requirements. Most importantly the IC/SS protocol is UCA (Utility Communications Architecture) compliant, assuring its ability to be easily integrated into a utility communications network and thus ideal for use in demand side management, distribution automation and automatic meter reading applications. IC/SS is also compatible with CEBus.

Deliveries are expected to be such as to give product in silicon by February 1992 and production samples by March-August 1992 (47)

5.3.11 **IEC Part 2**

The full title is International Electrotechnical Commission, Technical Committee No. 13, Working Group 14, Part 2 - Remote Meter Reading.

Again, an international standard, encompassing customer automation categories of meter reading, tariff control, load control, equipment and system checks and data services. Distribution automation categories will include monitoring, control and bulk metering measurement. (18,19)

In October, 1991 the Working Group reported that proposals had been accepted, that group activities on the application layer had been discontinued, that a first draft on user requirements was being prepared and that a proposed distribution line messaging system might be used for future work. (10)

The Legal Metrology Task Force provides an excellent communications network in itself, as can be seen, bringing together government, electricity, gas and water utilities and industry to provide up to date information on progress across a broad front.

In summary, the many, many standards and proposals for data communications - several of which being applicable to multi-utility automatic meter reading and demand side management services, are gradually being rationalised and normalised. A melding of the Utility Communications Architecture and the Consumers' Electronic Bus is probably the best direction, and is achievable.

6. BUSINESS OPPORTUNITIES

Business Opportunities abound in the whole area of Automatic Meter Reading, Performance Monitoring and Demand Side Management in Canada, for products, for systems, for services and in upgrading existing energy networks to include telecommunications.

6.1 The Smart Monitoring Device

Some two years ago, the Legal Metrology Branch of Consumer and Corporate Affairs, Canada formed a "Task Force on Standard Data Communications Protocol for Electronic Metering Devices". Their concern was that, in the metering of gas and electricity consumption (their only area of jurisdiction) there was no common communication technique for accessing electronic gas and electricity meters and that many of the parameters which they required were not generated.

The task force has been meeting frequently and has representatives from the electrical utilities, electrical meter and telemetry manufacturers (nearly all American). The Gas industry was not as well represented ("it would be of benefit to all of us if there were further participation from the gas utilities").

A specification for a "Smart Metering Device" (SMD) has been developed by four members, Richard Tucker (Duke Power); Kah-Fae Chan (Toronto Hydro), Glen Allen (Ontario Hydro) and Jean Joly (Hydro Quebec). (23) The device is, as would be expected, designed for electric power monitoring, although the protocol is sufficiently generalized to allow any computation, linear or non-linear, for use by different utilities. Information can be encrypted and decrypted. Richard Tucker has requested three U.S. companies to submit RFPs for development. It would be disappointing if this Canadian initiative were to result in American product.

A requirement specification should be developed in Canada, for a product useable by the Electricity, Gas, Water, District Heating, District Cooling, Oil Fuel and possibly other

utilities. The product, for residential applications could have optional gateways for telephone, CATV, radio or power-line-carrier services. (Figure 19)

Figure 15 shows a block diagram for the Smart Metering (not "Monitoring", in that the electricity meter is part of the unit) Device proposed by the Legal Metrology Team. It proposes a communications module and interface, selectable at installation as telephone, power line carrier or cable television together with local communications for load control - perhaps hard-wired or using the CEBus power-line carrier system.

Such 'gateways' are already in development or being offered in the U.S., (123) one example being the EPRI Electric Utility Gateway System (Figure 16). Plexus Research provided such gateways for the Electric Smart House in Atlanta GA last year.

An interesting and extremely important facility shown in the block diagram of Figure 15 is the display module.

Increasingly, consumers need to know what they're consuming, at what rate, how much have they spent in the month and how can they make economies?

As a speaker said recently, energy is the only commodity that is used before its paid for.

An example of innovative work in developing this form of user interface is Hydro-Québec's Customer Interactive Energy Management Service (98) where customers are able to use an interface - a television receiver, an LCD display module or a videotext terminal to *accept or refuse* load-shedding commands and to read consumption, billing projections, indoor and hot-water temperatures and messages from hydro-Québec.

Three different telecommunications technologies were tested:

Cable television using Videoway's two way capability,

FM subscriber radio/telephone line

Paging system VHF radio/telephone line.

The videotex terminal used in the latter two trials was that developed by Northern Telecom. Highly innovative, it was designed rather like the French 'Minitel' service to provide access to a vast range of videotex services. It is now well known, in this Energy Management System (EMS) role, as the Alex-Gescon service.

Again, in Quebec, Societé de Microelectronique Industrielle de Sherbrooke and Hydro-Québec have introduced a 'Système de télécommande bi-energie' with a similar 'interface avec le client'. (97)

Ontario Hydro (141) have been testing and are very impressed with, the 'PowerStar' system offered by CIC Systems, Inc., of Brentwood NT (Figure 17).

Magnetically-striped cards are purchased, either through mail or at Powercard Dispensing Machines and inserted in the meter, when 'dollars remaining' 'present use ($/hr)', 'used yesterday', 'used last month', $ last purchase' and 'current rate, c/kWh' can be successively displayed.

Much work has been carried using these token payment techniques (115,116,117,118, 119,122) including very large trials deployments, particularly in the United Kingdom. (96)

The Credit and Load Management System developed by Mr. R.A. Peddie and his staff at the South Eastern Electricity Board (81,82,83 and 84) is particularly worthy of study. (Figure 18b)

The CALMU (Credit and Load Management Unit) when fully developed would have enabled the system to -

a. Measure within statutory tolerances and record electricity consumption (kilo-watt-hours) and demand (kilowatts/kVA);

b. Calculate outstanding charges to date on an on-going basis;

c. Enable all consumers to be charged at revised tariff rates from the same date (as against varying dates depending on the time meter readings are taken);

d. Enable meter readings to be taken remotely at will, thereby enabling accounts to be rendered more frequently than at present;

e. Accept payment against account;

f. Detect loss of supply on the consumer's premises, leading to more rapid restoration of supply than at present;

g. Monitor supply for low/high voltage and earth leakage;

h. Apply safeguards against tampering with CALMU;

i. In an emergency enable load shedding to be effected on a controlled basis;

j. Limit the amount of electricity supplied either on request from the consumer or in the event of non-payment of charges;

k. Through a touch panel attached to the CALMU, present information to the consumer, e.g. outstanding charges to date;

l. Facilitate improved load management leading to a reduction in the volume of system losses (units generated but not charged);

m. Engage in two-way communication via radio, power line carrier or telecommunications links;

n. Provide consumers with the facility to:

   (i) Have consumption and demand recorded separately for certain circuits in the premises or for particular periods in time in a day;

   (ii) Take advantage of attractively-priced tariffs which enable the utility to interrupt supply wholly or selectively for predetermined periods;

   (iii) Make payments to the utility by communicating through the touch panel attached to the CALMU.

Many of the features can be extended to gas and water supplies, details of which can be recorded separately from those for electricity.

In fact, the system developed into an Energy Management Unit (EMU) using British Telecom's BITSTREAM low speed data system. Again and not untypically of the telco, excessive tariffing for the telephone facility prevented its introduction.

Figure (18a) shows how rapid a penetration of dynamic pricing ("spot pricing") should be possible with real benefits 'within a few years'.

An example of this 'paying for only what you want' is Pay Television, where 'Pay per Programme' is being superseded by 'Pay Per View'. Incidentally the provision of these services is well-within the capability of a Smart Monitoring Device.

In fact, a myriad of control, billing and monitoring services would be available and Figure (19) shows the potential of a full roll-out offering.

6.2 A Turn-key Opportunity

Individual utilities often find it difficult, understandably to talk with each other (60); however the interposing of an 'honest broker' - in other words an independent company whose very success would depend upon its confidentiality would go a great way to enabling Multi-Utility Service Technologies to be developed.

Figure (20) shows a possible full service offering by such a company. Roles for such a firm could include

a. The provision of suitable meters and their certification
b. Meter installation
c. In site, or in workshop, meter modification
d. Purchase, or even manufacture and supply of suitable meter interface units (the Smart Monitoring Device)

e. Selection of an appropriate telecommunications medium - telephone, power line carrier, cable TV or even Very Small Aperture Satellites (VSATs) including the provision of equipment, its installation, commissioning and operation.

f. Provision and operation of the head end

g. The supply of (probably encrypted) billing and statistical information to the utilities - perhaps to include special load survey data.

h. Such a company could possibly issue bills on the utilities behalf.

One utility has suggested to the writer that their extensive software, developed expensively over many years, should be made available, particularly to the smaller municipal undertakings. The negotiations of fees, and more general availability of this software, could be another responsibility of such a turn-key company.

This concept of an "independent energy service company" is, however, is not preferred by Commissioner Stephen Wiel, who says -

> ".....the electrical industry ought to control its own destiny and not turn a major part of its future over to independent energy service companies. Utility companies have access to their customers to inform them about products, product availability, costs and benefits; to make sufficient capital available; and to provide accounting and billing for conservation measures. Utilities also have access to builders who make indirect purchase decisions; can provide information to them about products, product availability, costs and benefits; and can encourage more responsible behavior through promotional programs or through variable hook-up fees. A utility's customers are its future. The utility should be minimizing the exposure to risk of both stockholders and ratepayers by directly attending to the needs of its customers." (136)

Mr. Coleman feels differently (53)

"No longer would the utility have to rely on the telephone company exclusively for out bound AMR. The utility could contract with a vendor or some other third party to provide that service. Likewise, the utility could themselves interconnect to the switched services network. Such interconnections would allow the third party to avoid certain aspects of the telephone company's services. The ONA (Open Networks Architecture) procedure could be employed to "unbundle" the effected elements and facilitate third party access to only the critical monopoly components they require to provide a competitive AMR service. In exchange for such interconnections and associated "unbundling", regulatory commissions could provide the telephone company with pricing flexibility once competition is introduced."

Mr. Brown does not mince his words -

"Given the shortage, our domestic capital markets cannot support a continuing proliferation of business niches in local and statewide communication markets - where electric, gas, water, telephone, CATV, and microwave-wireless tv companies deliver service to and collect information from the same customers. Decision-makers in regulatory agencies, when confronted with a stream of separate requests to approve single-purpose local communication networks, will ask each utility a series of questions: Can scale-economies be achieved by centralizing communication functions over a common path? Is the current diversity of communication paths economically efficient? Have you performed any studies that compare the cost of the single purpose network with the incremental cost of adding your functions to a common network? Can the local economy afford the capital investment for all of these single purpose networks? These questions will be asked with increasing frequency because

of the country's poor performance on economic growth and because AMR technology has been commercialized much too slowly."

6.3 New-build and Upgrading Opportunities

The likely deregulation of telephone services in Canada is resulting in other (previously disparagingly called 'by-pass') companies seeking to develop or acquire their own telecommunications network. One example, previously mentioned (page 60) is of a disused district heating system being used to provide underground tunnels for the stringing of conductors - probably including fibre. The Utilities Telecommunications Council are well aware of this opportunity.(49, 131, 51)

6.4 Fibre Optic Distribution Systems

Since the laying of a utility service is labour intensive, the inclusion of fibre(s) with electricity, gas, water and district heating services should perhaps, be introduced now. Possibly the fibre could be included within the electricity, water, district heating and even gas lines (fibre carries no electricity). Some authorities consider (99) that such deployment, by the electrical utilities could represent the first major introduction of 'fibre in the loop' - the last mile - to the home. The fibre could remain 'dark' and leased co-operatively to the telcos, or a third party, or the system could be commissioned and offered on a bandwidth/time basis to commercial and industrial users - and to the cable television industry. (104)

An elegant technology exists for the introduction of fibre in buildings and underground, called 'blown fibre'. Small-bore plastic tubes are introduced by comparatively unskilled labour and high pressure air used later, to entrain the fibre and blow it, at high speed, to its destination. Fibres can be subsequently added or replaced. Below ground, up to 1km can be blown - in both directions simultaneously if necessary. An article is included here, as appendix VII. (132)

After several successful trials installations in the United Kingdom and in the Midland International Trade Services Headquarters (the 'City Spire') in New York City, these blown

fibre cabling installation techniques are to be used on the sixty-five building campus at the University of Utah. Sumitomo Electric Fiber Optics Corporation, a licensee, will carry out the project. (133)

These business opportunities it is suggested, are available and with little technology development. Again, there are large turnkey opportunities overseas (particularly in Europe and the Eastern European states) and Canada, with its deserved reputation in telecommunications, should seize these initiatives.

7.0 RECOMMENDATIONS

- That knowledge of Multi-Utility Service Trials be more generally known and disseminated amongst all electricity, gas, water, district energy and other utilities in Canada.

- To this end an Association be formed. The great interest in the first Toronto meeting is an indication of this need.

- That Canada be consistently represented at relevant codes and standards meetings, in particular –

  - the several committees of the joint Institute of Electrical & Electronic Engineers/Automatic Meter Reading Association's Standard Co-ordination Committee's SCC31.

  - the Consumer Electronic Bus (CEBus) subcommittees of the Electronic Industries Association (USA)

  - the Electric Power Research Institute's Utility Communications Architecture project, in order to ensure compatibility with Canadian standards and implementation programmes.

  - Working Group 1 "Home Electronic Systems" of the ISO/IEC JTC1/SC25. There is at present no consistent representation.

- That the work of the Task Force on Data Communications Protocol for Electronic Metering Devices (convened by the Legal Metrology Branch of Consumer & Corporate Affairs, Canada), be more generally known and that there be increased representation from Canadian Industry and Utilities.

- That a Canadian Chapter of the Automatic Meter Reading Association[11] be formed, analogous to the American Society of Heating, Refrigerating and Air-Conditioning Engineers' (ASHRAE's) Canadian Chapter.

- That the Automatic Metering Reading & Demand Side Management Industry together with the Canadian Government explore the possibility of providing assistance to Eastern European and the Commonwealth of Independent States in endeavours to improve the efficiency of their energy control systems.

- That further work be carried out in investigating the business opportunities in District Energy systems.

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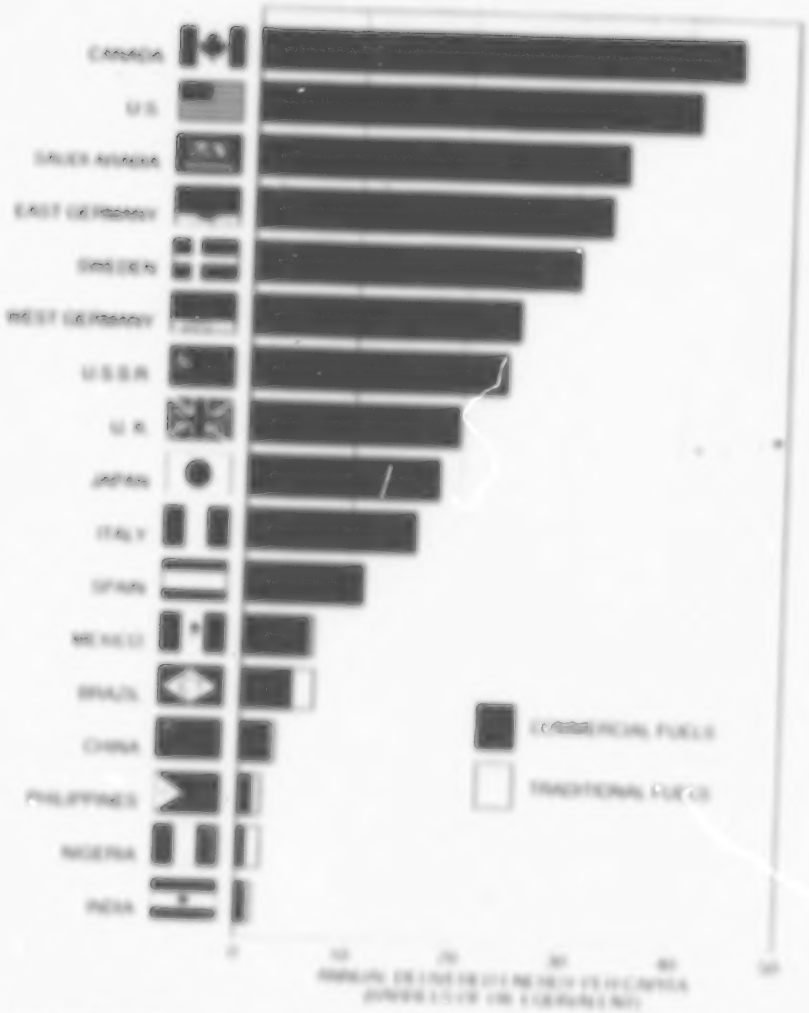
[11] Only seventeen Canadian representatives attended the important AMRA '92 Conference in Boston, out of a total of 211 attendees.

8. GLOSSARY

AM/FM	Automated Mapping and Facilities Management
AMR	Automatic Meter Reading
AMRA	Automatic Meter Reading Association
ANSI	American National Standards Institute
ARMR	Automatic Remote Meter Reading
ASK	Amplitude Shift Keying Modulation
Bellcore	Bell Laboratories after the deregulation of AT&T
bps	Bits Per Second (data rate)
BT plc	British Telecom
CATV	Community Antenna Television (Cable TV)
CCAC	Consumer and Corporate Affairs, Canada
CEBus	Consumer Electronics Bus
CHP	Combined Heat and Power
CIES	Community Integrated Energy Systems
CO	Central Office (telephony)
CSA	Canadian Standards Association
'D' Channel	The data channel within an ISDN system
DA	Distribution Automation
DAS	Distribution Automation System
DOC	Department of Communications (now Communications Canada)
DPA	Distribution Primary Analysis
DRTU	Distribution Remote Terminal Unit
DSM	Demand Side Management
DSP	Demand Side Planning
EE	Energy Efficiency
EEI	Edison Electric Institute
EIA	Electronic Industries Association
EMS	Energy Management Systems (Transmission)
EPRI	Electric Power Research Institute
ESCO	Energy Service Company
FM	Frequency Modulation
FSK	Frequency Shift Keying Modulation
Hz	Hertz (Cycles Per Second)
IDHCA	International District Heating and Cooling Association
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IEE	Institution of Electrical Engineers (Great Britain)
IEEE	Institute of Electrical and Electronic Engineers Inc.(USA)
ISDN	Integrated Services Digital Network

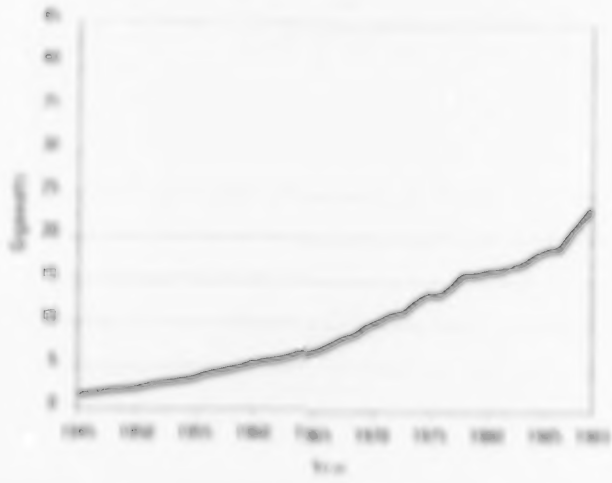
ISO	International Organisation for Standardization
IVP	Integrated Value-based Planning
KV	Kilovolt
kwh	Kilo watt hour
kwhr	Kilowatt hour (reactive)
LAN	Local Area Network
LC	Load Control
LCP	Least Cost Pricing
LM	Load Management
NFS	Network File System
OEM	Original Equipment Manufacturer
OSI	Open Systems Interconnection (reference model for protocols)
PBX	Private Branch Exchange
PEPCO	Potomac Electric Power Company
PLC	Power Line Carrier
PR	Packet Radio
PSK	Phase Shift Keying
PUC	Public Utility Commission
RBOC	Regional Bell Operating Company (a "Baby Bell")
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SLAC	Subscriber Line Access Controller
SSB	Single Side Band
TCP/IP	Trans Control Protocol/Internet Protocol
TES	Thermal Energy Storage
TOU	Time of Use
UCA	Utility Communications Architecture (EPRI)
UG	Utility Gateway
UHF	Ultra High Frequency (300-3000 MHz)
UL	Underwriters' Laboratories Inc.
UPS	Uninterruptible Power Supply
UTT	Utility Telemetry Trunk
VHF	Very High Frequency (300-3000 MHz)
VSP	Variable Spot Pricing
VLSI	Very Large Scale Integration (re: circuit design)
WAN	Wide Area Network
WC	Wiring Concentrator



World Per Capita Energy Use

Figure 1

Ontario Hydro: Past Demand, Rising Needs and Declining Resources



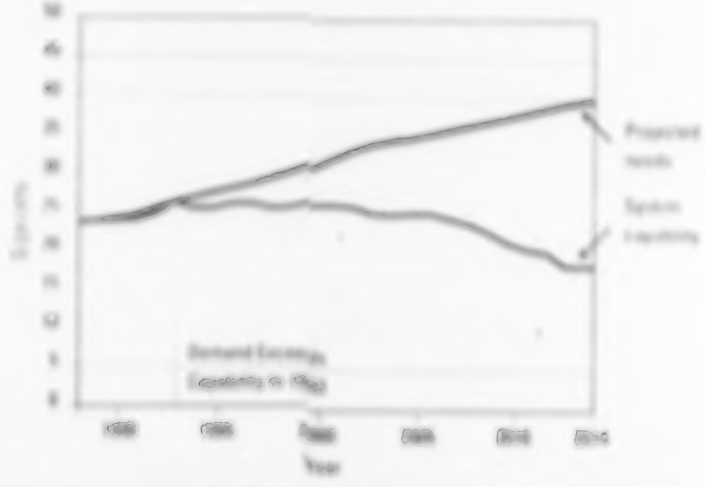
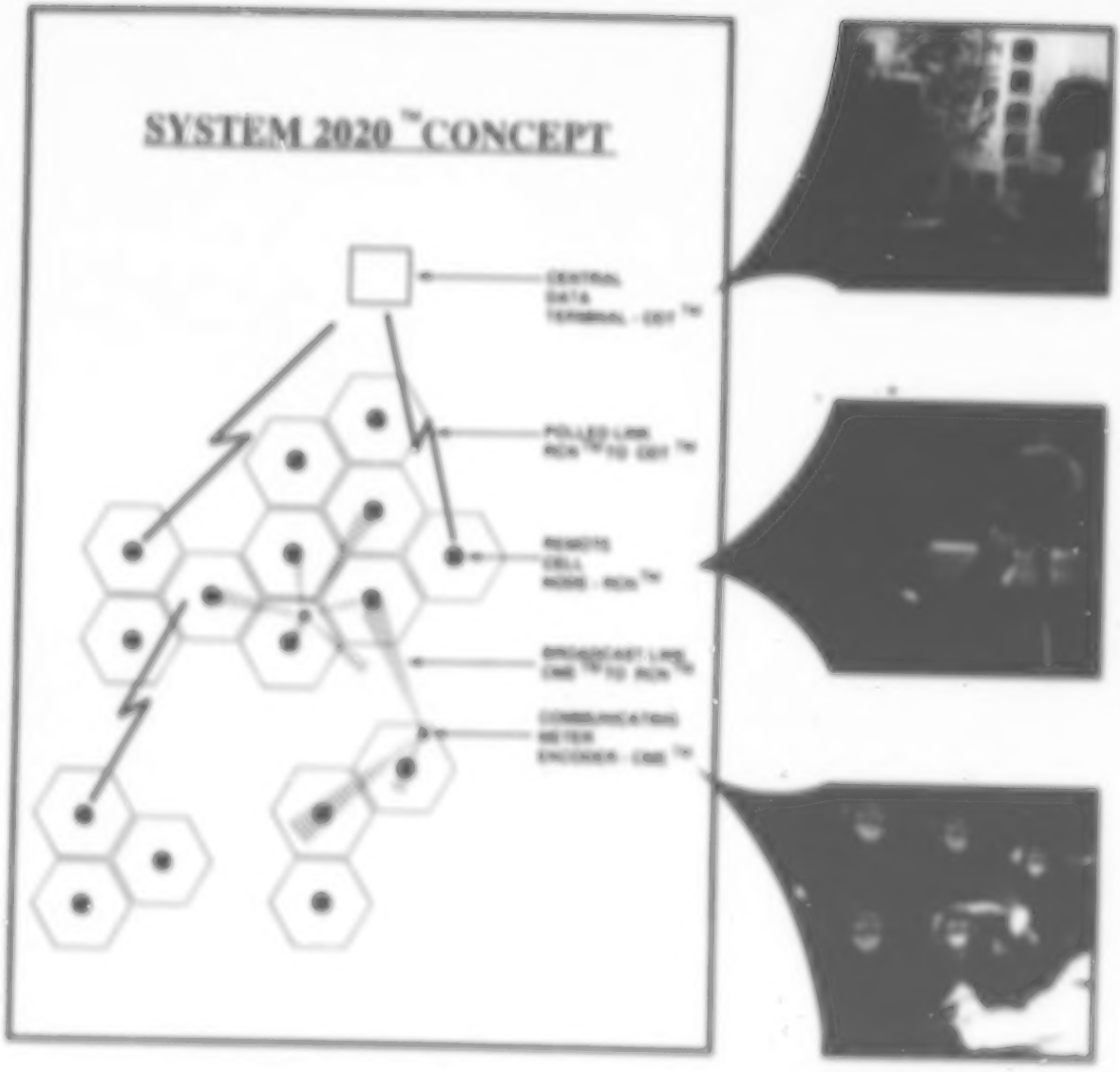
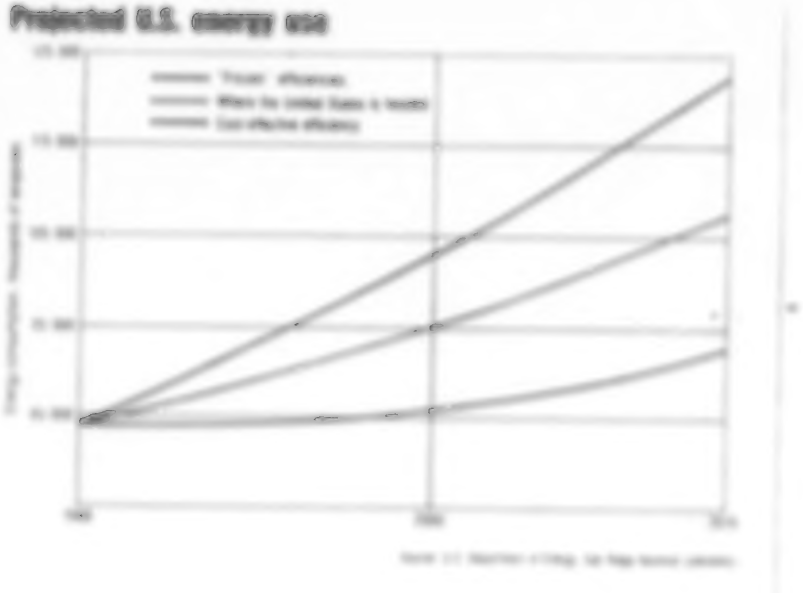


Figure 1



System 2020™ Concept (Iris Systems Inc.)

Figure 3



Projected U.S. Energy Use

Figure 4

POWER SMART INC.
(PSI)

PSI is a wholly owned subsidiary of the public utility, British Columbia Hydro and Power Authority. Our mission is to promote energy efficiency, and we do this by working directly with public and provider owned utilities, governments, manufacturers, retailers, and distributors.

The unique marketing approach taken by Power Smart makes it possible for utilities to quickly advance into the early cost-effective, environmentally friendly option to meet growing demand for energy and to delay the need for building new generating facilities. Power Smart works because it is a memorable name and an umbrella for proven DSM programs in the residential, commercial and industrial sectors. As well, it is an ethic that captures the imagination of the public in these times of environmental concern.

PSI members have the major benefit of "critical mass" which means:

- more influence with governments, manufacturers, retailers, distributors, and consumers
- advertising and promotion on a scale beyond the budgets of most utilities acting alone
- utilities working with utilities, sharing information on effective DSM programs

Membership gives your utility:

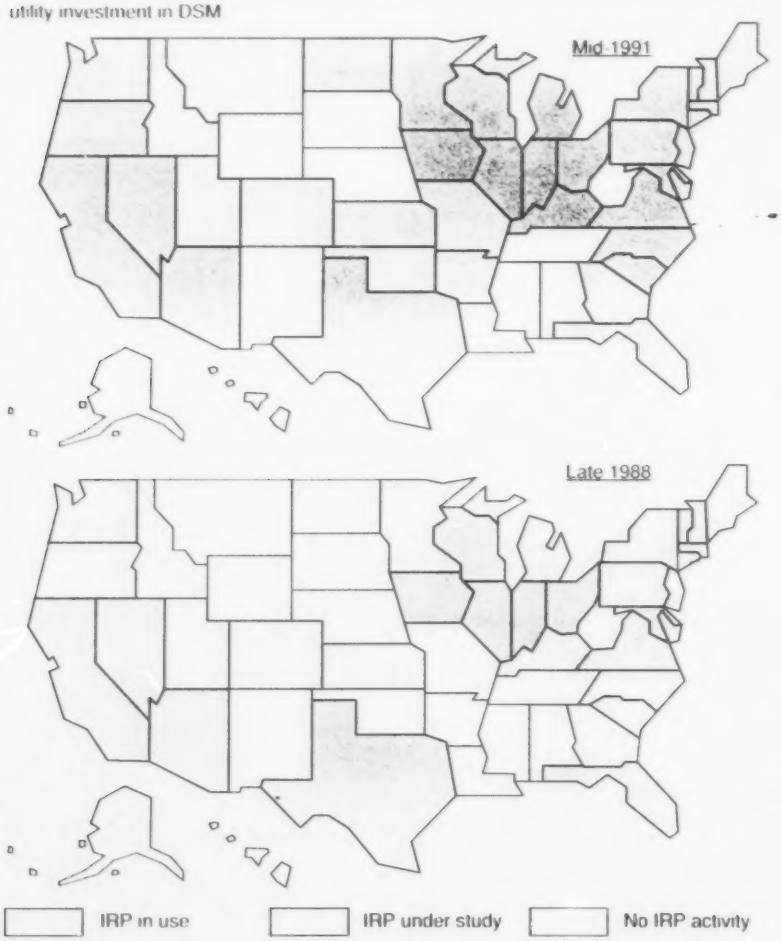
- use of the Power Smart name and logo
- participation in national identity programs and retail promotions
- PSI activities on your behalf:
  - program orientation sessions: an overview of major Power Smart programs with an opportunity to meet with specific program managers for more extensive discussions
  - Power Smart seal of approval identifying energy efficient products
  - PSI working with governments, manufacturers, distributors, retailers, non-member utilities, associations and others to promote energy efficiency
- access to DSM library - directories, program reference material, literature, etc.
- program catalogue
- sample brochures/literature
- technical literature for utility representatives and selected customers
  - Guides to Energy Management (30) technical papers covering the residential, industrial, commercial and farm sectors)
  - Electrical Energy Efficiency for Industry Design Guidelines & Standards reference guide
- Link! the newsletter about Power Smart, its members and activities

Consulting Services:

- modification and customization of programs and materials
- program launching assistance
- DSM Planning
- program implementation strategies / marketing, such as:
  - key account management systems
  - sales management and retail relations training
  - training workshops for industry
- marketing research

Integrated Resource Planning–Spreading Fast

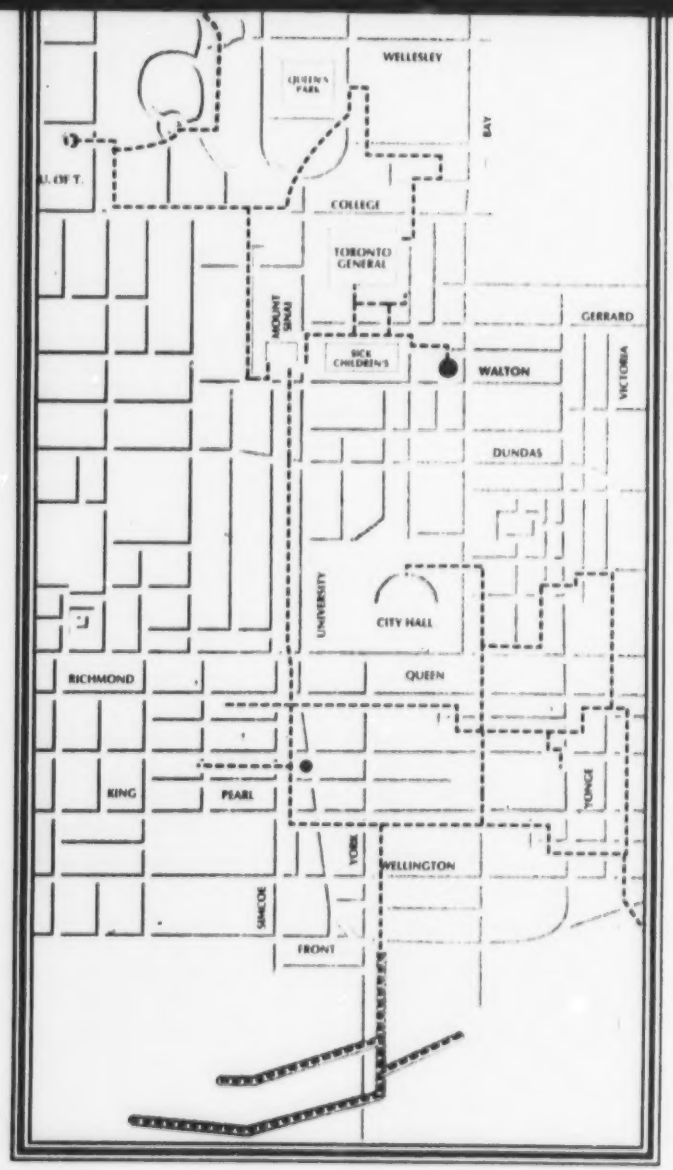
As of July 1991, 31 states have integrated resource planning requirements in place. That's a 35% increase over the number of states requiring IRP only two and a half years ago. IRP, which aims to achieve a mix of supply- and demand-side resources that satisfies energy needs at the lowest possible cost to utilities and consumers, is intended to encourage utility investment in DSM.



Integrated Resource Planning - Spreading Fast

Figure 6

Figure 7



DISTRICT HEATING SYSTEMS

Figure 7b Toronto District Heating Systems

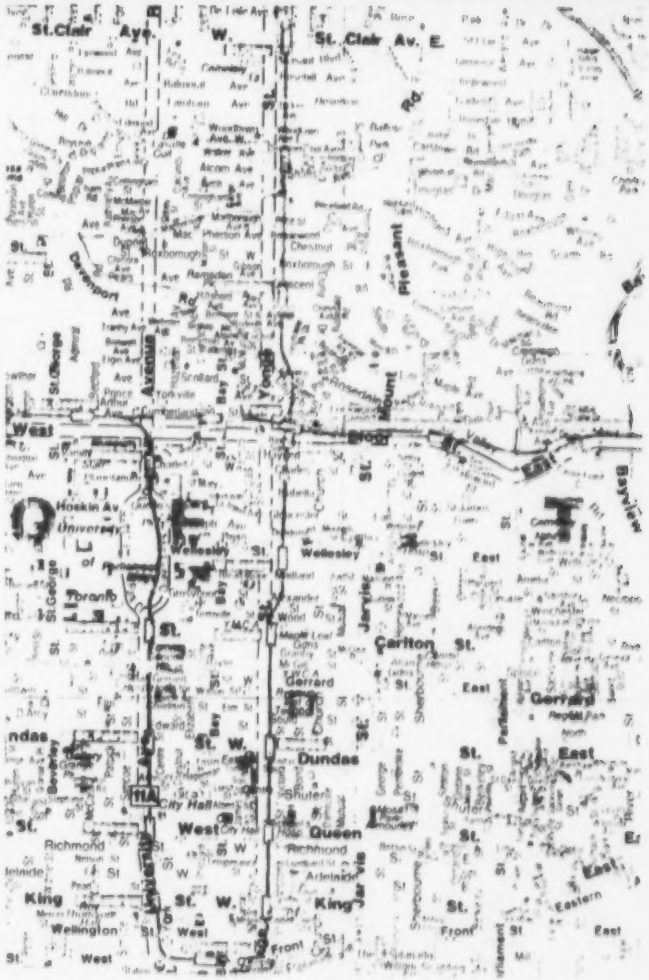


Figure 7a

Toronto Hydro-Possible Trial Area

VYING FOR SPACE ON THE SPECTRUM

Among the new services clamouring for specialized frequencies:

New land-based mobile communications systems: Cellular telephones as well as facsimile and data transmission linking car and truck fleets. Could require 300 megahertz (MHz) in the band now occupied by UHF television (400 to 700 MHz).

Mobile satellite services: Communications, messaging, paging and geographic positioning information by way of low-earth-orbit satellites. Small satellites would consume 5 MHz in the 800-900 MHz range; The Iridium system, ultimately employing dozens of satellites, would consume 16.5 MHz somewhere between 1850 and 1990 MHz.

Radio-based pocket-sized telephones: Would require between 100 and 200 MHz in the band between 1710 and 2500 MHz.

Radio links for personal computers: An Apple Computer plan would set aside a personal computer data transmission channel requiring 40 MHz in the 1710 to 2500 MHz range.

Advanced cordless telephones: Would require 4 MHz in the 800 to 900 MHz range.

High-quality digital radio: Land-based approach would require 10 Mhz somewhere between 400 and 2000 Mhz. The satellite approach, for nationwide broadcasts, would require 60 Mhz in the same area.

Auxiliary services for high-definition television (HDTV): The F.C.C. plans to set up HDTV broadcasting within regular television channels, but it must still find more space for other aspects of HDTV, like news broadcasts from remote areas. HDTV would need larger channels than those used now. The F.C.C. has not yet estimated needed bandwidth.

Source: Federal Communications Commission

Vying for Space on the Spectrum — New York Times June 2, 1991

Figure 8

Choosing a Medium

A wide variety of media are being used, at least experimentally, to link electric utilities with their customers. The characteristics of these media vary widely in such two-way communications systems, and two or more media may be used together in any particular system. While rapid technological improvements may change the relative advantages of various media substantially, most experts agree that the huge message-carrying capacity of fiber optics will eventually enable this medium to dominate the field.

Medium	Typical Data Rates (bits per second)	Relative Cost	State of Development	Advantages	Drawbacks	Other Issues
Fiber-Optic Cable	1.5 million–200 million	High	Trials	Virtually unlimited data rates. High immunity to interference.	Regulatory issues unresolved. Limitations on branching fiber-optic signals.	Fiber costs decreasing. Work continues on low-cost splicing.
Standard Phone Lines	110–20,000 (analog) 9600–1.5 million (digital)	Medium (analog) High (digital)	Established (analog) Trials (digital)	High system reliability. Infrastructure in place.	Telephone tariff uncertainties. Nonstandard utility connections to telephone equipment.	Utility must rely on third party for system performance and maintenance. There is steady movement toward digital systems.
UHF/VHF Radio	1200–40,000	Low	Trials	Easily expandable. Low operating cost.	Limited frequency availability.	Harsh radio environment due to frequency congestion in some areas. Terrain-dependent operation.
Long-Haul Power Line Carrier	60–300	Medium to high	Established	Infrastructure in place. Utility has complete control, and acceptance is high.	Circuit-conditioning equipment needed. Interference is high.	Inability to communicate when power is out. Reliability remains unproven.
Short-Haul Power Line Carrier	300–10,000	Low	Established	Logical component of hybrid system. Minimal circuit conditioning required.	Limited range. Interference is high.	Interference with customer equipment unresolved. Backup power required for operation during outages.
Coaxial Cable	1 million–15 million	Medium to high	Trials	Substantial infrastructure in place.	Two-way cable communication is costly and technically difficult.	Third-party ownership. Tariffs uncertain. Reliability may be low.
Satellite	1200–1.5 million	Medium to high	Trials	Good for geographically dispersed customers. Easily expandable.	Cost of two-way earth station is still high, and size of "dish" is still large.	Very small aperture terminals (VSATs)—small dishes—are under development. Reliability may be affected by weather.

Choosing a Medium

Figure 9

Functions of Two-Way Communication

The ability to establish two-way communication links to remote locations will enable utilities to implement many new functions related to their distribution networks. In a recent EPRI survey, utilities identified several dozen such functions as potentially important. Some of these functions, such as substation monitoring, pertain primarily to system operation. Others, such as those listed here, benefit customers more directly.

Detection of customer outage The extent of a blackout could be determined immediately, without having to rely on customer complaints or reports from field crews.

Faster service restoration After power interruption due to a fault on the distribution system, service could be restored more quickly by remotely analyzing line loading and performing automatic feeder reconfiguration, which would be facilitated by two-way communication with remote switches.

Power quality Voltage deviations and other power quality problems could be detected and remedial actions taken, such as addition of more capacitance to affected circuits. Flickering of lights and misoperation of customer equipment would be minimized.

Customer service information exchange Customers could receive messages from their utility, such as "Service representative has been dispatched to analyze voltage problem."

Automated meter reading Integration of "smart" electronic meters could eliminate the need for manual meter reading. First applications have involved commercial and industrial customers and residences in areas where access is difficult or dangerous.

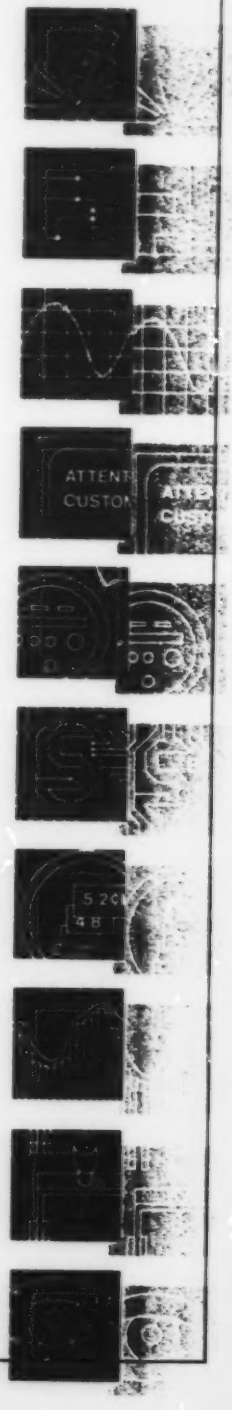
Electronic billing and payment Information gathered from the communications network could be processed automatically, and two-way links would make it possible for billing and customer payment to be done electronically.

New pricing strategies Customers would be offered more choice through pricing signals downloaded from the utility to a smart meter. The utility, in turn, could track energy usage relative to new pricing strategies by conducting instantaneous load surveys.

Load curtailment In return for lower rates, selected loads on customer premises could be turned on and off remotely, with two-way communication providing verification of load reduction. Load curtailment with two-way communication is expected to focus initially on commercial and industrial customers.

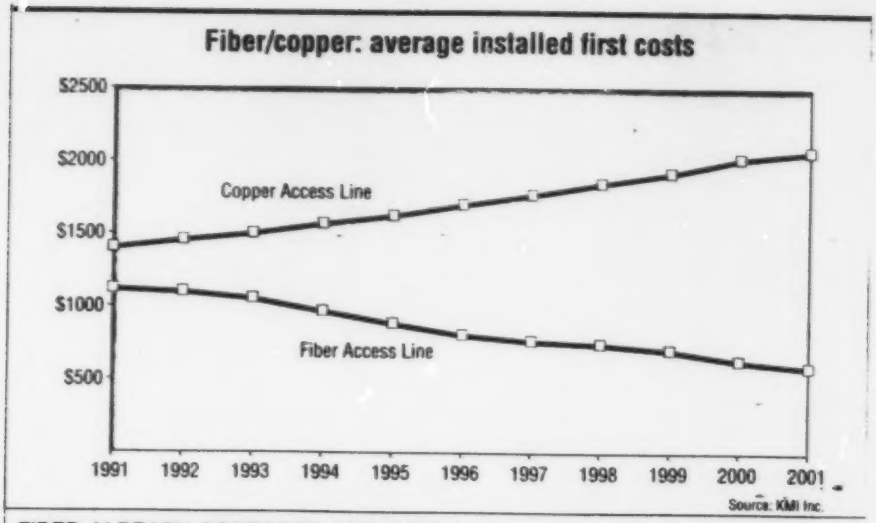
Remote service turn-on/turn-off Remote connection changes mean faster and more convenient service for customers moving into or out of a home or apartment, since no utility service representative would have to be dispatched.

Nontraditional services Utilities that want to diversify their business could offer new services, such as security monitoring of homes and offices.



Functions of Two Way Communication

Figure 10



FIBER ALREADY COMPARES FAVORABLY *with copper on an average installed first-cost basis. By 1995/1996, fiber will also be competitive in case-by-case installations.*

Figure 11a Fiber/Copper: Average Installed First Costs

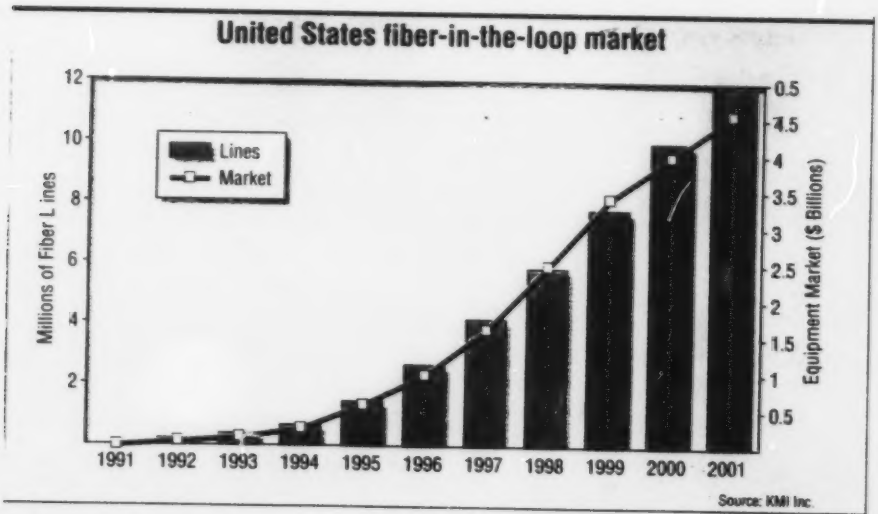


Figure 11b

United States Fiber-in-the-Loop Market

TELEPHONE COMPANIES WILL BE MOVING *from fiber-in-the-loop trials to actual deployment beginning in the mid-1990s, according to Kessler Marketing. The company predicts the number of fiber residential access lines to climb from 6000 in 1991 to 3 million in 2001, with sales of fiber-in-the-loop gear reaching $4.5 billion in the same period.*

Figure 11

WORKING TOGETHER

The UCNet system is a perfect marriage of technology partners. We at GE Meter and Control

tions, and Ericsson GE Mobile Communications provides the wide area communications technology. With this reliable two-way communications system, the possibilities are endless. Information interchange with your customers, flexible time-of-use

rates, real-time pricing, direct load control, remot
service connects and di nects, and interruptibl
rates are merely a few o . .Net's extensive
capabilities.

The UCNet system isn't a mere voice dispatch
ing system, or just a load management system, or
only an automatic meter reading system. UCNet is
fully integrated, reliable, cost-effective, two-way voic
and data communications system. And it's your k
to improved service and increased productivity.

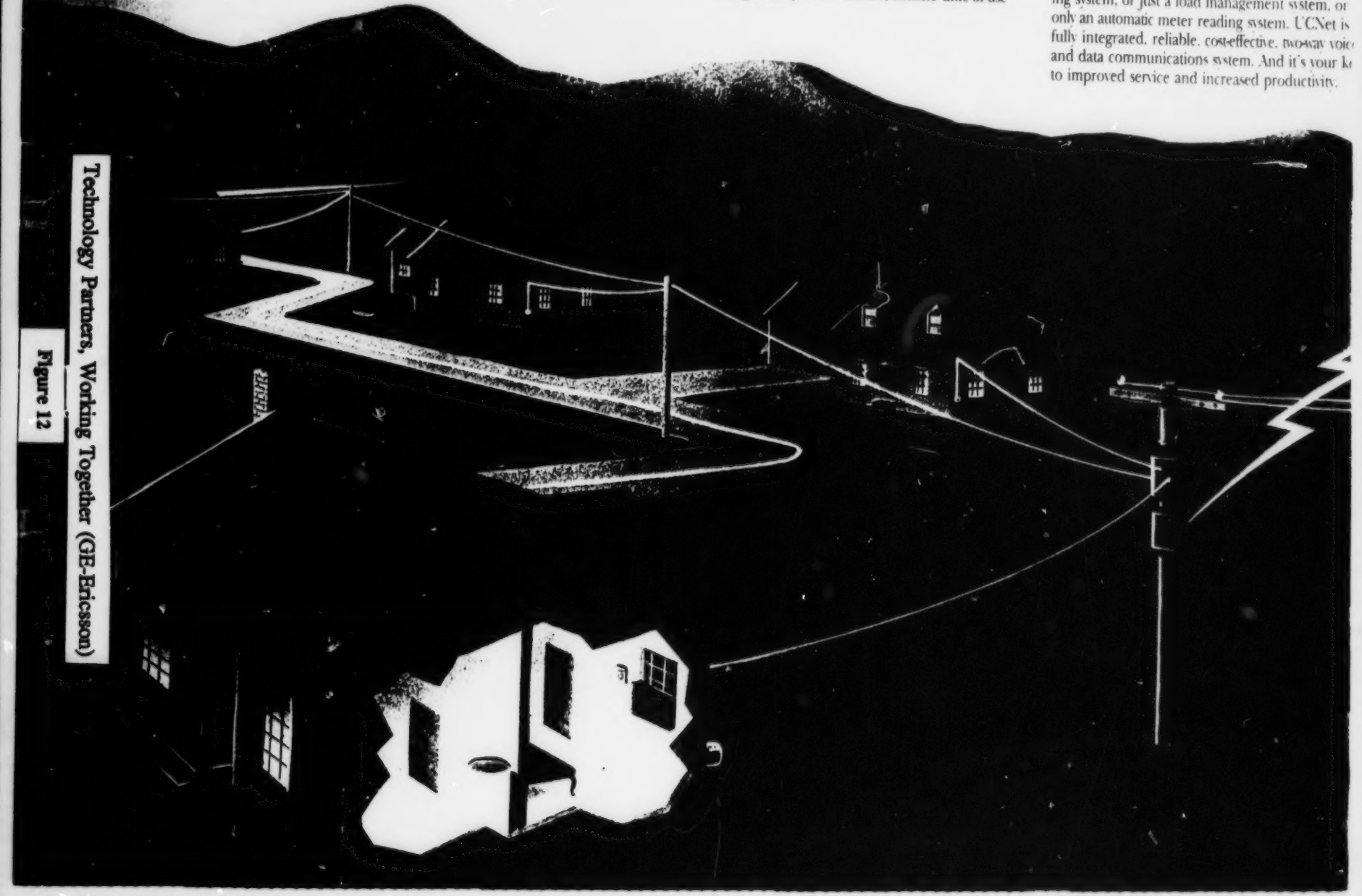
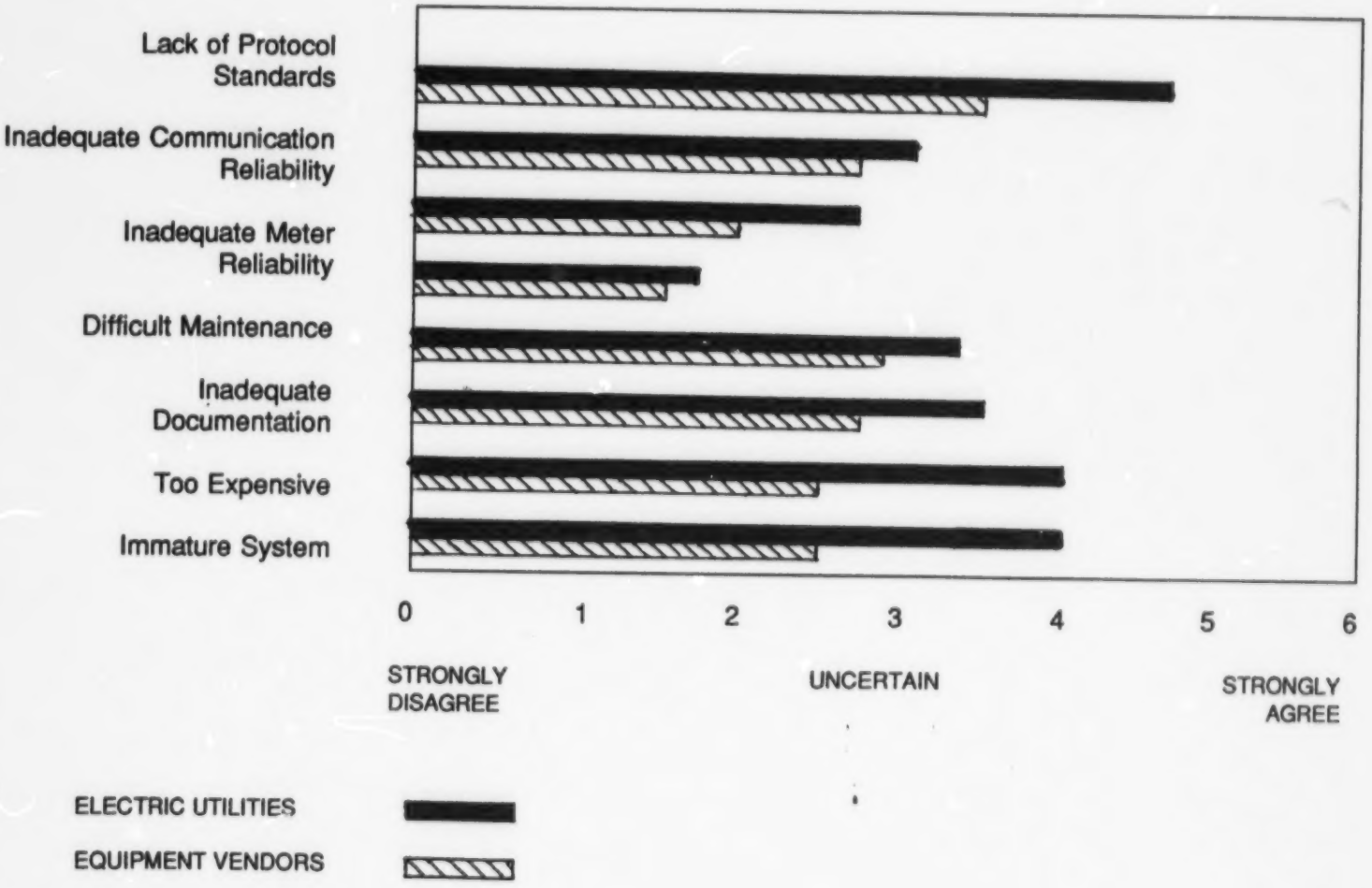


Figure 12 Technology Partners, Working Together (GE-Ericsson)

PROBLEM AREAS LIMITING SYSTEM IMPLEMENTATION



Problem Areas Limiting System Implementation

Figure 13

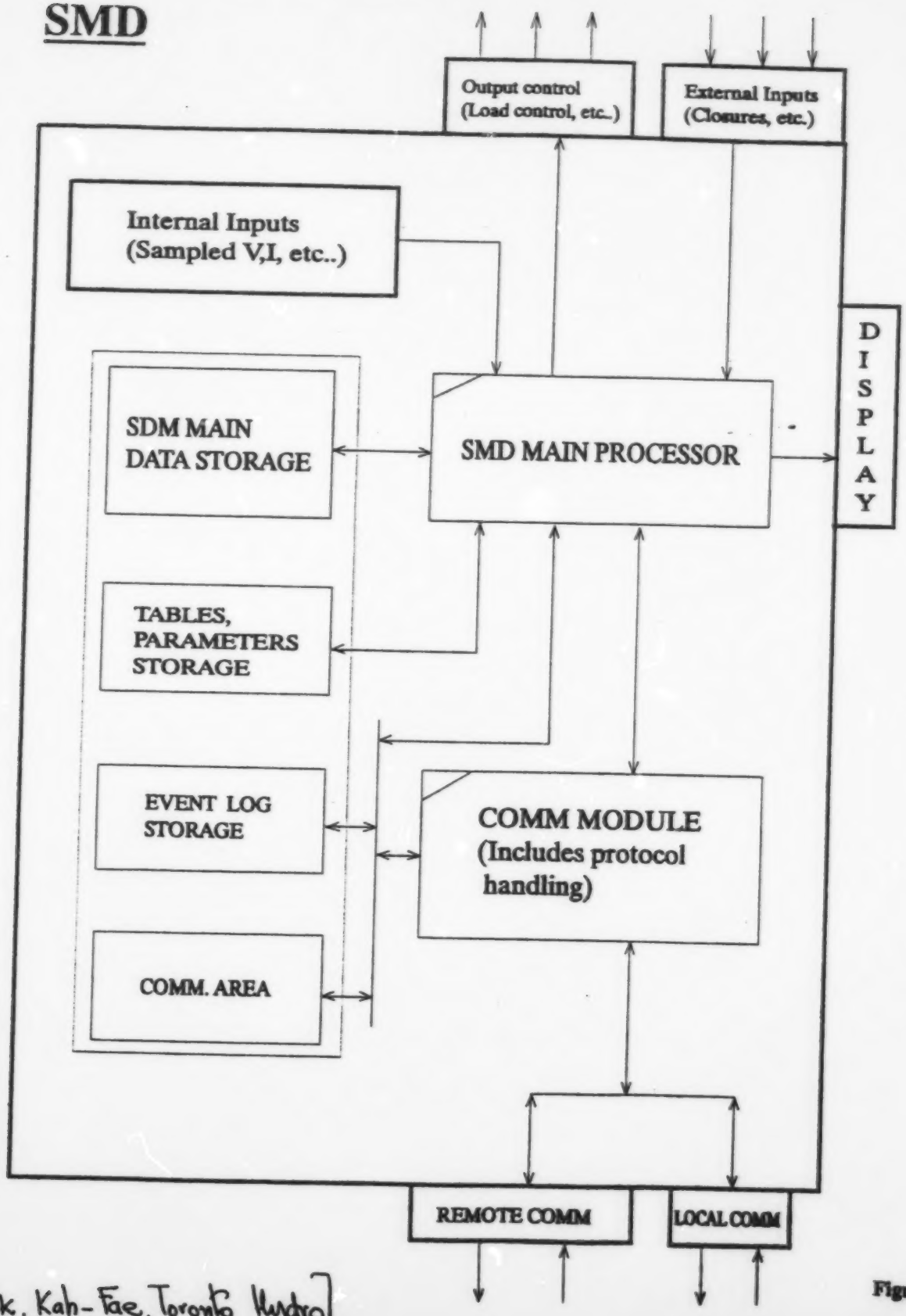
"EPRI's Business Case Study" AMRA News, September 1991.

Figure 14

©1991 Tom Bowling and Associates

10/7/01

The Smart Metering Device - Possible Block Diagram



k. Kah-Fae, Toronto Hydro]

Figure 15

Honeywell

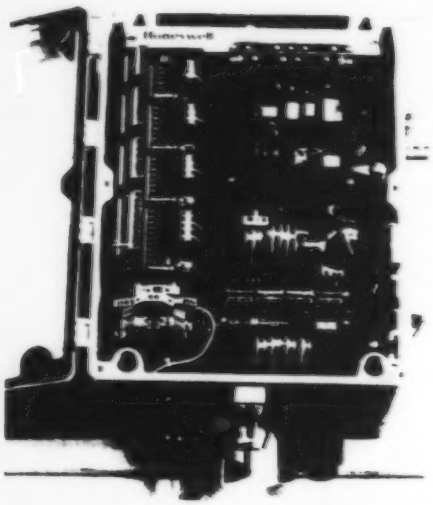
Sensor and System Development Center

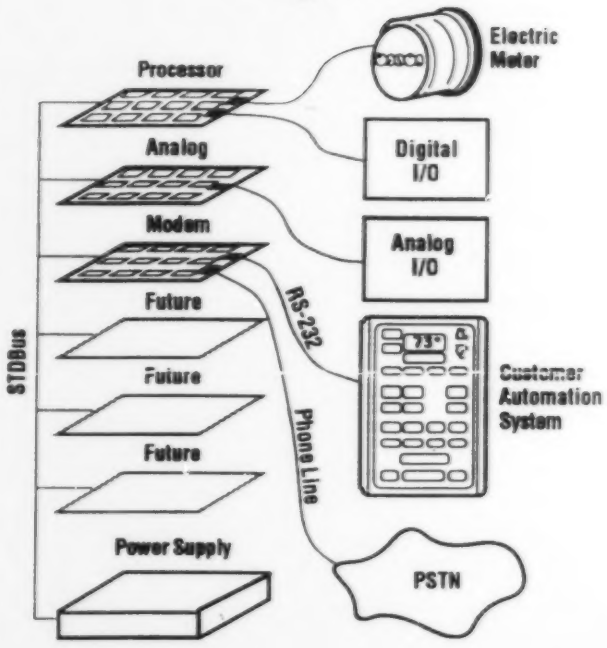
Electric Utility Gateway (EUG) System

Developed by Honeywell Under Contract to EPRI

The EUG is a protoype communications gateway to allow the exchange of information between an electric utility and the resources of an intelligent home or commercial building. Standard communication protocols are used for the utility and customer interfaces and can be easily updgraded to conform to the Utility Communications Architecture (UCA) protocol specifications. The system has a 36-day data logging capability (15-minute sampling), multiple analog and digital input channels and automatic fault detection and isolation capabilities.

A companion system to the EUG is the Utility Master Station (UMS). This system is used to simulate typical operations that would be performed by an electric utility in the dissemination to and collection of information from t' " customers via the EUG. Examples of information that can be exchanged include real-time meter readings, outdoor air temperature, tamper detect status, power outage data and submetered log files. The UMS is implemented on a Compaq 386 PC.





Features

- 80C88 processor at 5 MHz
- VRTX multitasking operating system
- Battery backup for up to 100 days
- Local real-time clock
- Power fail detection circuitry
- 2400 b/s modem
- RS-232 port
- 8 preconditioned A/D channels
- Operating temperature range of –10° to +120°F
- Dimensions are 14 x 10.5 x 7.4 in.
- Maximum power is 0.5 A at 120 Vac
- Power supply is surge protected

Honeywell

Helping You Control Your World

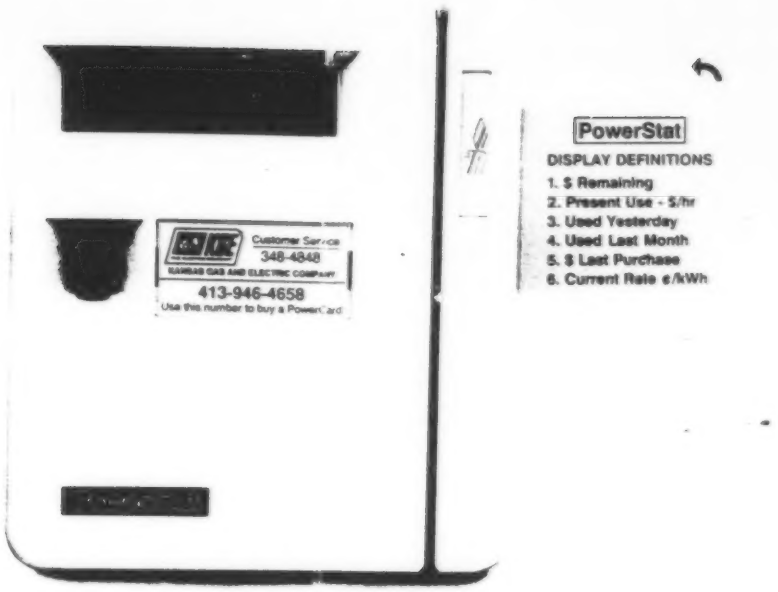
The following individuals may be contacted for more information:

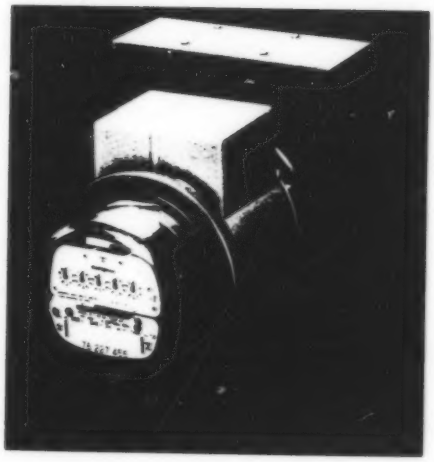
Dave Myers (612) 782-7753
Dan Miller (612) 782-7046

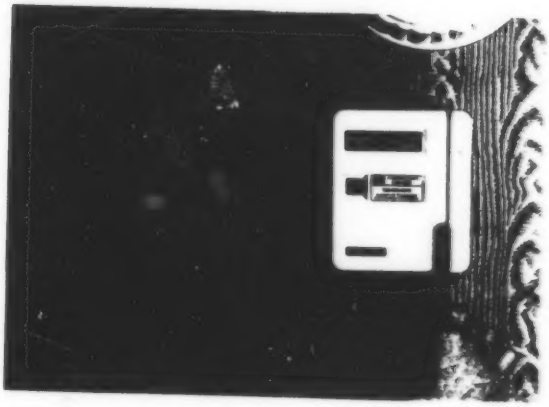
Sensor and System Development Center
3660 Technology Drive
Minneapolis, MN 55418

Figure 16

Electric Utility Gateway System (Honeywell)

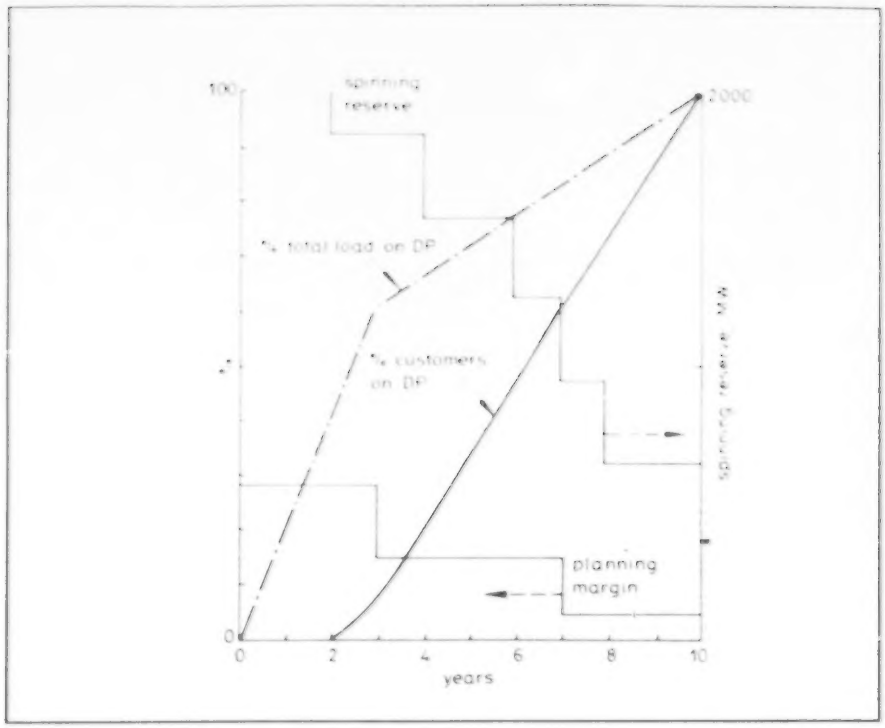






The Power Stat System (C.I.C. Systems, Inc.)

Figure 17



1 Well planned replacement of old meters would allow most of the load to be channelled through smart meters within a few years of their introduction. Within 10 years, the real benefits would become clear

Figure 18a Smart Meters: Real Cost Benefits (UK)

Calmu

Calmu 3, a development of the original Calmu, is a typical modern electronic meter and consists of standard components for a mass-production device: microprocessor, non-volatile memory and display.

Metering is carried out using a simple 8 bit built-in analogue-to-digital convertor, which reads input voltages and currents 3000 times per second. The rest of the metering is simply working out all the required parameters from the mass of data received. Calmu actually works out 40 different parameters once a second, making them available to the rest of the system as stored variables, with an accuracy of 1 in 10^5 at full scale. An RS232 optical port can be used by any 'dumb' terminal to transmit these values.

Thus, if *Q*1 is sent to the meter, it replies: 1=0·987 (being the power factor during the last second in circuit 1, or red). It will even tell you the angle between the three voltages in a three-phase supply (nominally 120°, but in practice varying by up to ±3°). The most important quantity – energy – is added to continuously in the non-volatile memory, so that no special action is necessary if the mains fails.

Complex tariffs can be installed in the meter using different charges at various times of day and seasons of the year. These can be written to the meter at the same time as routine meter reading using a rugged hand-held unit.

A standard 64 bit security system, similar to the system used in banking, is used to prevent unauthorised access. This is an absolutely vital part of the system, without which any hacker would regard the meter as a legitimate target. The security system provided is effectively unbreakable within the life of the meter; a fully published version of the whole system would still take 2^{64} attempts to break the code, and only ten tries per day are allowed.

The possibilities for a fully programmable meter are limited only by the imagination of the programmer. Thus, accounts, communication control and external switch controls are all being exploited now. How many new possibilities will the future bring?

Figure 18b The CALMU3 System (UK)

Figure 18

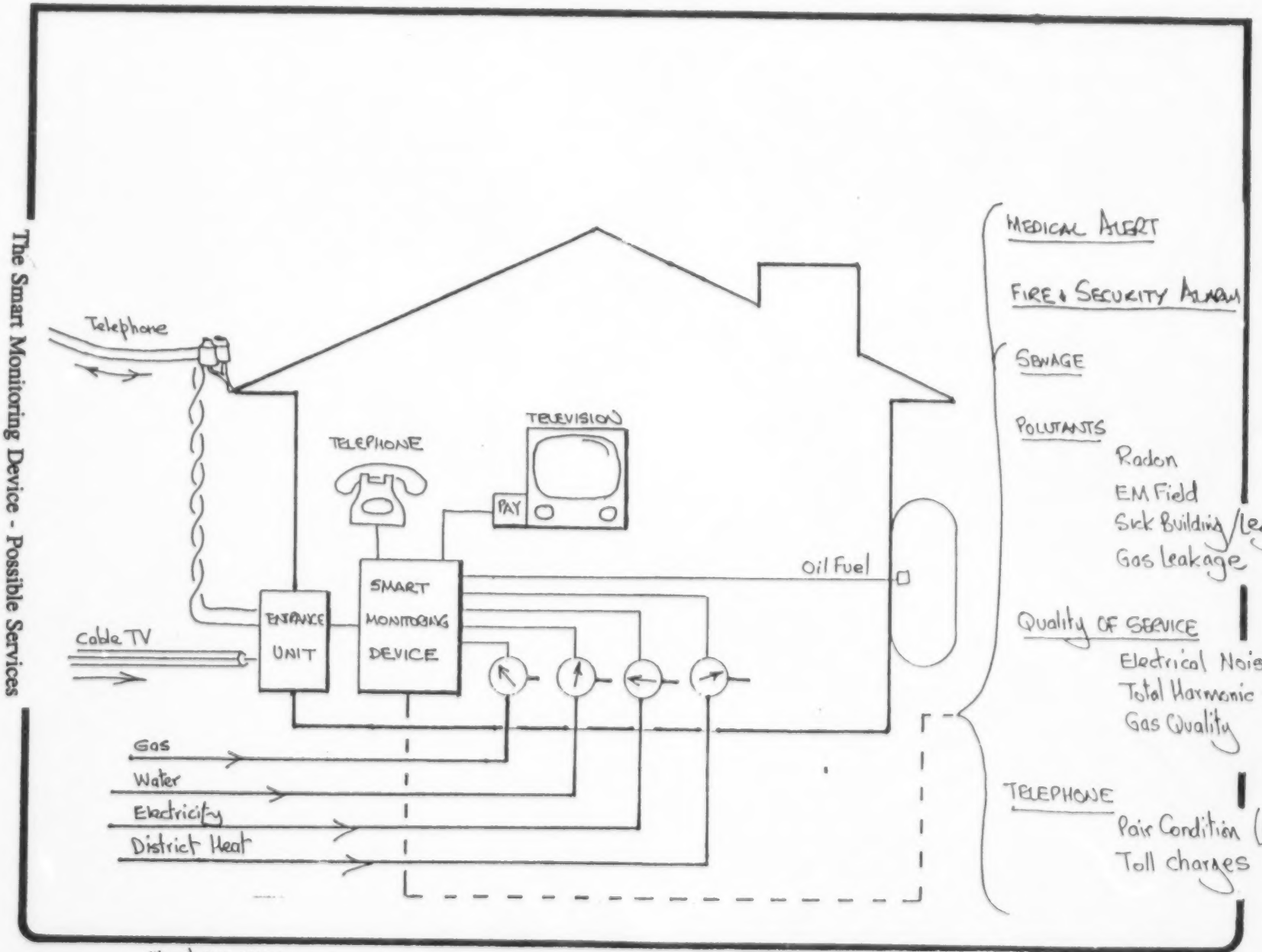


Figure 19 The Smart Monitoring Device - Possible Services

MULTI-UTILITY AUTOMATIC METER READING & DEMAND SIDE MANAGEMENT
- A NEW BUSINESS OPPORTUNITY
E
G
W
and others
MIU
INSTALLS + MAINTAINS METER INTERFACE UNITS
INSTALLS METERS OR MODIFIES IN SITU
CHOSES AND OPERATES THE COMMUNICATIONS MEDIUM (TELCO, CATV, PLC, RADIO) AND ENCOURAGES (& SPONSORS) INSTALLATION OF FIBRE BY UTILITIES
HEAD END
OPERATES ITS OWN HEAD END
COMPUTER
PROVIDES BILLING & STATISTICAL SERVICES AND DEMAND SIDE MANAGEMENT IF REQUIRED
INFORMATION TO UTILITIES
BILLS TO CUSTOMERS

Multi-Utility AMR/DSM: A New Business Opportunity

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Figure 20

Water Utility	# Services	# Meters	Electric Utility	# Cust	Gas Utility	Pop'n	# Cust	Telephone Compa
Peel	130000	130000	Mississauga Hydro	94484	Consumer's Gas	383205	88281	Bell
Peel			Brampton Hydro	49265	Consumer's Gas	193135	45832	
Regina	46000	46000	Sask Power	396133	Provincial Gas	180003	56150	Sask Tel
Edmonton	180000		Edmonton Power	233048	Northwestern Util.	576249	170287	Edmonton Telepl
Scarborough PUC	100000	100000	Scarborough PUC	117146	Consumer's Gas	496599	87441	Bell
Richmond Hill	18000	18000	Richmond Hill Hydro	14941	Consumer's Gas	47916	22339	Bell
Toronto	150000	30000	Toronto Hydro	209251	Consumer's Gas	627351	122145	Bell
Ottawa	135000	135000	Ottawa Hydro	121585	Consumer's Gas	308162	38853	Bell
Ottawa			Nepean Hydro	29821	Consumer's Gas	97839	15556	Bell
Ottawa			Kanata Hydro		Consumer's Gas	28196	6176	Bell
Ottawa			Gloucester Hydro	27197				Bell
Calgary Water	135000		Calgary Electric	245581	Canadian Western	647285	202946	AGT
Saskatoon			Saskatoon Elect Dept		Provincial Gas			Sask Tel
Winnipeg	165000	165000	Winnipeg Hydro	89640	ICG	595099	168718	Manitoba Tel
Winnipeg			Manitoba Hydro	355273				Manitoba Tel
Thunder Bay PUC	33500	31600	Thunder Bay PUC	42936	ICG	112518	31066	Thunder Bay Te
Moose Jaw			Sask Power		Provincial Gas	35522	11817	Sask Tel
Swift Current			Sask Power		Provincial Gas	16144	5509	Sask Tel
Prince Albert			Sask Power		Provincial Gas	34369	10633	Sask Tel
Durham	70000	70000	Ajax Hydro	10821	Consumers Gas	37449	8905	Bell
Durham			Oshawa Hydro	38317	Consumers Gas	126693	17980	Bell
Durham			Pickering Hydro	15551	Consumers Gas	50163	11394	Bell
Durham			Whitby Hydro	13739	Consumers Gas	46946	9893	Bell
Etobicoke	65000	65000	Etobicoke Hydro	92102	Consumers Gas	310426	51596	Bell
Kingston PUC			Kingston PUC	23111	Kingston	62179	5761	Bell
London PUC			London PUC	91227	Union Gas	276000	70915	Bell
Vaughan Water	23000	23000	Vaughan Hydro	21615	Consumers Gas	66658	13184	Bell
Penticton		5000	Penticton Pub Works	11472	Inland Nat. Gas	23588	6612	
Haldimand Norfolk		7000						Bell
Hamilton Wentworth	102000	42000	Hamilton Hydro	119529	Union Gas	307690	74313	Bell
Hamilton Wentworth			Stoney Creek Hydro	13812	Union Gas	41964	10632	Bell
Markham	40000	40000	Markham Hydro	35448	Consumers Gas	117416	33602	Bell
Kitchener			Kitchener-Wilmot Hyd	51505	Kitchener	147439	28448	Bell
Waterloo			Waterloo North Hydro		Union Gas	63265	14208	Bell
Cambridge					Union Gas	77343	18377	Bell
Windsor			Windsor Util Comm	67183	Union Gas	195028	56522	Bell
Vancouver Water	110000		B.C. Hydro	1184266	B.C. Gas Inc.	549598	134543	
Halton			Burlington Hydro	35559	Union Gas	115593	29743	Bell
Halton			Milton Hydro	10099	Union Gas	30988	6011	Bell
Halton			Halton Hills Hydro	11678	Union Gas	17296	4074	Bell
Halton			Oakville Hydro	25870	Union Gas	83214	24730	Bell
Chathan PUC	14000	14000	Chathan PUC	14616	Union Gas	41586	13195	Bell

APPENDIX I

Automatic Meter Reading Association

1990 Symposium

Multi-Utility Partnership

Trial Agreement

Paul Arsenault - Manitoba Telephone System

Ted Cotton - Manitoba Hydro

September, 1990

APPENDIX II

CNR MARKET DATABASE

Water Utility	# Services	# Meters	Electric Utility	# Cust	Gas Utility	Pop'n	# Cust	Telephone Company
Peel	130000	130000	Mississauga Hydro	94484	Consumer's Gas	383295	98281	Bell
Peel			Brampton Hydro	49265	Consumer's Gas	193135	45832	
Regina	46000	46000	Sask Power	236133	Provincial Gas	180003	56150	Sask Tel
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Ottawa			Gloucester Hydro	27197				Bell
Calgary Water	125000		Calgary Electric	245581	Canadian Western	547225	232946	AGT
Saskatoon			Saskatoon Elect Dept		Provincial Gas			Sask Tel
Winnipeg	165000	155000	Winnipeg Hydro	39648	ICG	595099	168718	Manitoba Tel
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Moose Jaw			Sask Power		Provincial Gas	35522	11817	Sask Tel
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Hamilton Wentworth	102000	42000	Hamilton Hydro	119520	Union Gas	307650	74313	Bell
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Cambridge					Union Gas	77343	13977	Bell
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Chatham PUC	14000	14000	Chatham PUC	14616	Union Gas	41586	13195	Bell

CNR MARKET DATABASE

APPENDIX I

Table of Contents:

1. Introduction
2. Utilities Participating
3. Background to the Trial
4. Preparation of Agreement
5. The Agreement
6. Conclusion

Introduction

A unique situation has developed in Manitoba! Five utilities have used their longstanding business relationship to form a multi-utility partnership. Through the efforts of this partnership a comprehensive agreement to pursue a telephone-based automatic meter reading trial, has been produced in Winnipeg.

Winnipeg is 75 miles North of the Canada and United States border, 1500 miles from Vancouver to the West, and 1300 miles from Toronto to the East. The population of Winnipeg is 634,000 ; the main industries are grain, manufacturing, and transportation.

Utilities Participating

1. MANITOBA TELEPHONE SYSTEM

   The Manitoba Telephone System (MTS) is a crown corporation owned by the province of Manitoba. The MTS 1988 annual report states MTS has 534,819 main telephone sets in service and employs 5212 people.

2. I C G UTILITIES (Manitoba) LTD.

   ICG Utilities is owned by West Coast Energy of Vancouver British Columbia. ICG Utilities has 210,000 customers and employs 605 people.

3. WINNIPEG WATER UTILITY

   Winnipeg Water is a department of the City of Winnipeg. Winnipeg Water has 171,907 customers and employs 353 people.

4. WINNIPEG HYDRO

   Winnipeg Hydro is a department of the City of Winnipeg. Winnipeg Hydro has 92,000 customers and employs 643 people.

5. MANITOBA HYDRO

   Manitoba Hydro is a crown corporation owned by the province of Manitoba. Manitoba Hydro has 372,069 customers and employs 4310 people.

August 1989:

Interutility Committee requested MTS proceed with finalizing the draft trial agreement.

October 1989:

MTS agreed to proceed with the AMR trial.

November 1989:

The Interutility Committee established a Project Team to be responsible for the planning implementation and operation of the AMR trial.

January 1990:

The five utilities established a Management Board to provide overall direction for the Project Team.

Preparation of Agreement

In February 1990 the Project Team began finalizing the draft agreement.

We felt the final agreement was necessary to:

1. Identify a definite set of objectives for the trial
2. Specify a time frame for the start and completion of the trial.
3. Specify the costs for the trial and identify what costs each utility is responsible for.
4. Specify the work to be done and identify what work each utility is responsible for.
5. Provide a legal document to cover issues such as assignment, liabilities and confidentiality.

A major consideration in the preparation of the agreement was that it be general enough to cover all suppliers of telephone outbound AMR equipment.

The Project Team first surveyed people in the industry looking for other trial agreements. We were hoping to draw upon the experience that other multi-utility AMR trials had gained in preparing agreements and putting them into practice.

Background to the Trial

The five utilities have been working together on Automatic Meter Reading for a number of years:

April 1984:

Manitoba Telephone System (MTS) approached the various metered utilities servicing Winnipeg customers. A multi-utility study group was formed and met periodically to discuss existing and potential meter reading systems.

MTS prepared a general specification for pricing an AMR trial system.

January 1985:

MTS tabled a proposal for a 200 point trial involving all four metered utilities in Winnipeg.

April 1985:

The five utilities began evaluating the suitability of various AMR technologies and drafting a trial agreement.

June 1987:

The four metered utilities, through the ongoing Interutility Committee, wrote MTS requesting its participation in the trial.

October 1987:

MTS provided the metered utilities with a preliminary cost estimate.

December 1987:

The metered utilities initiated a detailed cost determination study at the Interutility Committee meeting.

September 1988:

MTS provided the metered utilities with a cost estimate for a 100 point one year AMR trial.

October 1988:

Utilities began budgeting for the AMR trial.

The Agreement

***** DRAFT *****
AGREEMENT

This AGREEMENT made this _____ day _____, 1990.

BETWEEN:

THE MANITOBA TELEPHONE SYSTEM
(hereinafter referred to as "MTS"),

OF THE FIRST PART,

MANITOBA HYDRO - THE ELECTRIC BOARD
(hereinafter referred to as "Manitoba Hydro"),

OF THE SECOND PART,

THE CITY OF WINNIPEG
(hereinafter referred to as the "City of Winnipeg"),

OF THE THIRD PART,

- and -

ICG UTILITIES (MANITOBA) LTD.
(hereinafter referred to as "ICG")

OF THE FOURTH PART.

WHEREAS the parties hereto desire to install and operate an Automatic Meter Reading System in the City of Winnipeg, on a trial basis, and have agreed to do so on the terms and conditions contained herein;

NOW THEREFORE THIS AGREEMENT WITNESSETH that in consideration of the mutual covenants and promises herein contained the parties hereto agree as follows:

1.0 **DEFINITIONS**

For the purposes of this Agreement:

Our search for another agreement turned up a blank. The only documents resembling an agreement, that were being used for AMR trials, were one page letters of understanding, or verbal "gentlemen's agreements".

The AMR Project Team then began working to make the 1985 draft agreement into the official agreement to be used for the Winnipeg AMR trial. In August 1990 our official AMR Trial Agreement was complete.

The Agreement was the result of taking the original 1985 draft and adding input from, the AMR Project Team and four lawyers

The completed agreement was then sent to the AMR Management Board for approval and signing.

"Utility" (or "Utilities") means Manitoba Hydro, the City of Winnipeg and ICG. In this agreement, the City of Winnipeg shall, for all purposes, be considered as being two separate Utilities, which are referred to separately as "Winnipeg Hydro" and the "City of Winnipeg Water Utility".

2.0 AGREEMENT

2.1 The parties hereto agree to operate the AMR system with a minimum of 90 and a maximum of 100 MCU's. There will be a minimum of 90 and a maximum of 100 meter reading devices connected for each of ICG and The City of Winnipeg Water Utility and a minimum of 45 and a maximum of 50 meter reading devices connected for each of Winnipeg Hydro and Manitoba Hydro, in the City of Winnipeg, on a trial basis (hereinafter referred to as the "AMR service trial"), on the terms and conditions set out herein.

3.0 OBJECTIVES OF THE AUTOMATIC READING SERVICE TRIAL

3.1 The objectives of AMR service trial are as follows:

(a) To determine whether the Utilities can accurately read the meters of their respective customers over the AMR system.

(b) To identify the economic benefits, price, tariff and operational characteristics of the AMR system which would be required by each Utility in order to proceed beyond the AMR service trial.

(c) To gain an insight into customer attitudes to the concept of the AMR system and the development thereof.

(d) To investigate whether a cost-effective full service implementation strategy may be developed, including, without limiting the generality of the foregoing, a cost-effective method for installation of automatic meter reading devices.

'Automatic Meter Reading System', hereinafter referred to as the 'AMR system') shall mean a system for the automatic reading of Utility meters, configured for reading only, which is intended to operate as follows:

(a) A Meter Communications Unit (herein after referred to as an "MCU") is to be installed on each customer's premises. One side of the MCU is to be connected to a telephone line and the other side is to provide an interface for the gas, water and electrical meter reading devices (hereinafter referred to as "meter reading device") which are to be installed on the existing or new, if necessary, meters of the respective Utilities. The MCU at each premises is to be accessed through the telephone line by a computer/terminal located at the Utilities and MTS premises.

(b) The AMR system is to operate under computer control such that each Utility is able to obtain meter readings at any time of the day or night. Automatic rescheduling of unavailable readings is to be under computer control.

(c) When a meter is accessed by the AMR system, an exact reproduction of the actual reading of the meter is to be printed on paper on the hard copy terminal and is to detail:

i) the time and date of access,

ii) the location of the meter by customer address and/or account number and meter number if necessary, as preferred by the individual Utility,

and

iii) the meter reading at the time of access.

1.2 "City" means Winnipeg Hydro and the City of Winnipeg Water Utility.

1.3 "Customer" means a person who uses telephone, hydro, gas and water services thereof.

5.2 The Management Board shall be responsible for the managing and carrying out of the terms of this Agreement, and for coordinating the activities of the parties hereto to effect the objectives of this Agreement. All decisions of the Management Board shall be by majority.

5.3 A team (hereinafter referred to as the "Project Team") shall report to the Management Board. The Project Team shall consist of a Project Manager from MTS, one project Coordinator from each of; MTS, Manitoba Hydro, Winnipeg Hydro, The City of Winnipeg Water Utility and ICG. In the event that any member of the Project Team is unable to act

because of illness or other reasonable cause, the party that appointed said member may designate an alternate member who shall be entitled to participate in the decisions of the Project Team in the same manner as the original member. The Project Team shall be responsible for all activities related to the installation and operation of the AMR system, and carrying out the decisions of the Management Board.

5.4 The Project Team shall provide the Management Board with progress reports and other such data as the Management Board may require.

6.0 LIABILITY

6.1 Each party hereto assumes all risk of loss, damage, cost and expense to its property which may result from or arise out of the performance or non-performance of this Agreement, except that in the case of, or in the event of, any damage or injury to any persons which injury or damage was caused by or resulted from any negligent acts or omissions of any servants, agents or employees of a party to this Agreement, then, in such case or in such event, such party shall be solely liable for any such loss, damage, costs or expenses.

4.0 AMR SERVICE TRIAL ARRANGEMENTS

4.1 MTS and each of the Utilities hereto shall share equally (up to a maximum dollar value of-------- dollars to be paid by each of the parties hereto) the reasonable costs incurred by MTS for the purchase and installation of the AMR system and all associated equipment and accessories and for the costs incurred in launching and operating the AMR Service Trial.

4.2 MTS shall own and install the MCU and install and connect the wire from the MCU to the meter reading devises.

4.3 Each Utility shall purchase and own, and shall, at its own expense install the meter reading devices and all associated equipment and accessories thereto, and shall install such modems, terminals and any appurtenances thereto, as are necessary for the operation of the AMR system.

4.4 Each of the parties hereto shall be responsible for the costs of maintaining equipment which it purchases and installs pursuant to this Agreement.

4.5 There will be no tariff or fee of any kind charged by MTS for the use of the AMR system during the trial period.

5.0 MANAGEMENT OF AMR SERVICE TRIAL

5.1 Overall direction of the AMR service trial shall be provided by a Board (herein referred to as the "Management Board") comprising five members: each party hereto shall provide one member, except The City shall provide two members to the Management Board. The MTS member shall not be the chairman of the Management Board. In the event that any member of the Management Board is unable to act because of illness or other reasonable cause, the party that appointed said member may designate an alternate member who shall be entitled to participate in the decisions of the Management Board in the same manner as the original member. The Management Board shall meet at regular intervals which shall not be less frequent than four times a year.

6.2 Any party to this Agreement (including any servants, agents or employees of such party), whose negligent acts or omissions may cause or may result in claims, demands, suits, actions, costs, damages, expenses or proceedings being brought by third parties, shall indemnify and save harmless all of the other parties to this Memorandum of Agreement from any such claims, demands, suits, actions, costs, damages, expenses or proceedings.

7.0 EFFECTIVE DATE

7.1 The provisions of this Agreement shall become effective on the date of execution hereof by all parties hereto.

8.0 TERMINATION

8.1 The AMR service trial shall terminate one year from the date of the functional operation of all meter reading devices.

8.2 The AMR service trial may be terminated at any time by a majority decision of the Management Board.

8.3 Any one of the Utilities hereto may withdraw from the AMR service trial, following commencement of the use of the system, by providing 30 days advance written notice to the Management Board.

8.4 Upon the termination of the AMR service trial, the following provisions shall apply:

(a) No Utility shall be bound to proceed to full service implementation of the AMR system;

(b) Those Utilities that decide not to continue with AMR beyond the AMR service trial shall have their meter reading devices and associated equipment and accessories disconnected from MTS's MCU; and

(c) The disposition of hardware or software which is jointly owned shall be decided by a majority of the Management Board.

9.0 CONFIDENTIALITY

9.1 Subject to the law and any court process, all documentation, information and data supplied by the parties in furtherance of the objectives and purposes of the AMR service trial shall be treated as confidential and shall not be disclosed to any outside party without the prior written consent of the originating party.

9.2 The parties agree to share with each other all information derived from the pursuit of the objectives of the AMR service trial set out in Article 3 herein with further agreement that each party hereto may use all such information, except individual customer account information, for its own purposes.

10.0 AGENCY

10.1 Nothing contained herein shall be construed as establishing any agency, partnership or joint venture relationship between the parties, or any of them, for any purpose whatsoever.

11.0 ASSIGNMENT

11.1 No party shall assign or transfer this Agreement or any of the rights and obligations under this Agreement without the express written consent of all of the parties hereto.

12.0 SUCCESSORS AND ASSIGNS

12.1 This Agreement shall be binding upon, and its benefits inure to, the parties hereto and their respective successors and assigns.

13.0 AMENDMENT

13.1 The provisions of this Agreement may be amended, in writing, by the parties hereto.

14.0 NOTICE

14.1 Any notice or other communication between the parties hereto under the terms of this Agreement shall be in writing and may be given in any of the following ways:

(a) delivered personally; or

(b) delivered by registered mail during periods of normal mail service, postage prepaid, in which case notice or communication shall be deemed to have been received on the fifth day following the date of mailing.

14.2 Any notice or other communication to Manitoba Hydro under this Agreement shall be sent to:

Manitoba Hydro
Management Board Representative-AMR Trial
820 Taylor Ave.
Winnipeg, Manitoba
R3C 2P4

14.3 Any notice or other communication to MTS under this Agreement shall be sent to:

Manitoba Telephone System
Management Board Representative-AMR Trial
Box 6666, 360 Main St.
Winnipeg, Manitoba
R3C 3V6

14.4 Any notice or other communication to ICG under this Agreement shall be sent to:

ICG Utilities
Management Board Representative-AMR Trial
444 St. Mary St.
Winnipeg, Manitoba
R3C 3T7

14.5 Any notice or other communication to Winnipeg Hydro under this Agreement shall be sent to:

Winnipeg Hydro
Management Board Representative-AMR Trial
223 James Ave.
Winnipeg, Manitoba
R3B 3L1

14.6 Any notice or other communication to The City of Winnipeg Water Utility under this Agreement shall be sent to:

The City of Winnipeg Water Utility
Management Board Representative-AMR Trial
1500 Plessis Road
Winnipeg, Manitoba
R2C 2Z9

15.0 EXTRAORDINARY EVENTS

15.1 No party shall be liable to another party for any failure to perform or delay in the performance of any obligation under this Agreement caused by circumstances beyond its reasonable control, including but not limited to, strikes, acts of God, fire and war.

16.0 SURVIVAL OF TERMS

16.1 Articles 6.0 and 9.0 shall survive the termination of this Agreement.

In WITNESS WHEREOF the parties hereto have caused this AMR Trial Agreement to be executed the day and year first above written.

THE MANITOBA TELEPHONE SYSTEM

Per: _____
Director Marketing

MANITOBA HYDRO

Per: _____

THE CITY OF WINNIPEG

Per: _____

_____

ICG UTILITIES (MANITOBA) LTD.

Per: _____

Conclusion:

1. The agreement is valuable as it sets out a clear direction for who does what when.

2. Working together brought out a better appreciation for all Utilities' needs and a better understanding of individual situations.

3. The experience of working together made completion of the vendor selection matrix a cooperative rather than a confrontational effort.

4. More time is needed than each utility "going alone".

5. The process of preparing the agreement turned out to be more valuable then the Agreement itself. Handling all the work and decision making required to get the trial started went very smoothly because we had already learned to work together so well. The excellent relationships that were established during the preparation of the Agreement should mean that the agreement is a mere formality.

VENDOR AND PRODUCT

SELECTION PROCESS

MICHAEL A. CAWOOD
MANAGER OF NETWORK SERVICES
SASKTEL INTERNATIONAL

APPENDIX III

VENDOR AND PRODUCT SELECTION PROCESS

A lot has been written about Automated Meter Reading (AMR) in the last few years. In fact so much is now available, that most interested users find that an afternoon's light reading will barely scratch the surface of the documentation. The writings to-date have generally focused on economics, products, how to get started, installation and benefits. Very little has been written about vendor and product selection.

At first glance one would think that this topic of vendor and product selection would just simply be a matter of common sense. Most readers would be right in that thought. You buy the product that you want from a vendor that you know. Consumers over the years have been bombarded with words on how to choose a reputable seller of merchandise or how to pick merchandise or products to meet one's needs. Ask any household shopper about the purchase of a product from a seller and they can give you reams of advice on what to look for in that selection.

Vendor and product selection in the AMR field is basically no different from the acquisition of any other technology with the exception of the critical focus of AMR. It would be safe to say that most product acquisitions for an energy utility are for service upgrade, improvements, better reliability or feature enhancement. Very few of those acquisitions will actually change the way a utility collects revenue from a customer, especially when that revenue collection procedure has been so successful in the past. That's the danger of an AMR product acquisition process because AMR changes the utility access to their "cash register" (meter).

I mentioned earlier the revenue collection procedure that the utilities have used so successfully to date. Without going into any great detail on the existing collection process; because so much has already been written about it; it has generally consisted of a human intervention at the consumption meter to read and transcribe the data from the meter head for further processing at another location. Events, however, over the last 15 years have conspired to make this process less successful. The Arab oil embargo of 1973, labour costs, energy costs, invoice challenges, double income instead of single

income households, environmental concerns and the need for more sophisticated billing procedures are some of those events. On a typical walk route in some areas of North America, a 50% access rate is considered good. Utilities are being forced to reconsider and change their metering process and the collection of that metering data for billing procedures. Here is where the AMR selection process for vendor and product becomes so critical. As I said before, the utility is now tinkering with his cash register.

There are really two phases to the vendor and product selection process. Most utilities will go through a trial or limited deployment phase, then to a full deployment phase with their vendor or product choice. The trial phase is the time to make mistakes and learn from them and establish the new procedures. All the critical questions that need to be asked about vendors and products must be asked during this time-frame. Once full deployment is underway, it is generally too late to change the selection process in any significant way. My focus in this paper will be on the trial phase.

The first step in any vendor and product selection process is to review the goals of those entities that will be affected by the acquisition of any new AMR technology. The entities could include some or all of the following in any one trial situation.

-Telephone utility
-Electric, gas, water utilities
-Regulators
-Consumers and customers

The telco can be passive or active in its approach to AMR, depending on the regulations in the area, and can be looking for potential loop revenue enhancements and/or future service offerings. The energy utilities will be looking for cost reductions, energy management, reliability and future service potential. The regulators will be monitoring rates and regulations while the consumers will be looking for price stability, accuracy and transparency. As you can see there are already a wide range of forces begining to influence the selection process. The above are just a few of the more common goals, but I think they are a few of the more important ones. Unique situations may have unique or different desires that will still have an enormous influence on the selection process.

The next step of the process is to determine who will be the prime driving force behind the trial. This step will also begin the selection process of the type of AMR technology that may be acquired for deployment. Each utility has had experiences over the years with vendors and products that are unique to their own industries. Relationships and perhaps partnerships may have been established that will have a significant impact on what each trial partner will bring to the trial table. Each utility may have a different technical and monetary stake in the trial that may preclude any significant choices in the selection process. It is imperative that during this phase, all trial partners be part of the discussion to determine and agree to each level of utility control and participation.

In general a trial will limit itself to only one type of AMR technology but may use a variety of vendor's meters for diversity. The more common AMR technologies are, but not limited too:

-Telephony inbound/outbound
-Cable television
-Radio frequency
-Handheld

Each of the above technologies will allow different levels of control for the various utilities. The first two will require a teaming with a utility that historically has not teamed with any other for metering data and information gathering. Forming non-historical relationships will significantly impact the vendor selection process.

Once you have established your goals and formed whatever partnerships and determined the parameters for your trial, the actual vendor and product selection process can begin. This paper will now separate the vendor selection process from the product selection process in order to study them both in greater detail.

The vendor selection process should focus on only five main criteria. Others will argue that there are many more, but basically I think that the following five are the most important and have the most impact. They may not all be apparent at the beginning of a trial but will come to light as the trial progresses. The five main vendor selection criteria that I have selected are:

-Background
-Product
-Support
-Relationships
-Future

When you are researching the background of a vendor you need to ask the following types of questions. They are not listed in any degree of importance, but obviously some will carry more weight in the selection decision.

-How long has the vendor been in the AMR technology
-Has the vendor also been involved in the data collection or energy management related fields
-Will the vendor be in business in 10 or 15 years if full deployment takes that long
-Is the vendor financially stable
-How big is the vendor
-Can the vendor offer a full range of AMR services
-Does the vendor offer a tried product or will the utility be a guinea pig for that product
-Does the vendor have previous trial experience
-Will the vendor share previous trial experiences

From a product point of view the questions to be asked are really straight forward and again are in no special order. These questions are not product specific as you will see in the product selection process, but are more a product scope analysis.

-Can the vendor's product interface with other products from the same vendor
-Can the vendor's product interface with products from other vendors
-Does the vendor have products with open or published standards
-Does the vendor manufacture or subcontract the product process
-Is the vendor an integrator of a variety of products
-Will the vendor publish the unit and trial costs of the trial process
-Can the vendor meet your potential deployment demands for product

-Can the vendor provide a warranty service and does he support it himself
-Does the vendor provide product sales support offices in your utility area

The support area focuses on the vendor support for his product as opposed to the support requirements of a utility for a product that has been acquired and deployed. This area is very critical in the initial phases of AMR deployment.

-Does the vendor provide hardware support and at what cost
-Does the vendor provide software support and at what cost
-Does the vendor provide long-term or short-term support in other areas
-Does the vendor make available training in the areas of installation, repair, retrofit, billing procedures, maintenance and any software requirements and at what cost
-Will the vendor assist in any AMR marketing that may be required and at what cost

Once you have established the background and the present capabilities of your proposed vendor it's now time to look at his future potential

-Where is the vendor going with his AMR products
-Does the vendor have research and development facilities and budgets
-Will the vendor meet future or proposed AMR standards with his product line if he doesn't already
-Will any new product introduced by the vendor in hardware or software be backwards compatible or upgradeable
-Does the vendor exhibit or publish any plans to improve his product line or diversify
-Does the vendor seem interested in any suggestions or improvements to his product suggested by a utility during a trial

The last of the five main attributes is relationships. AMR is not a fad technology that will come and go very quickly. Once accepted and deployed it will sustain itself over decades and it is quite likely that the vendor of choice will become more than a simple provider of product. Some of the questions you may want to ask in this area are:

-Will the vendor establish a prescence in your territory for procedures such as sales, marketing or manufacturing
-Is the vendor open to approaches or development in other fields of related technology
-Will the vendor assist in obtaining approvals for new products from the appropriate regulatory bodies
-Will the vendor continue to exhibit the same level of concern and approachability if you as a utility choose not to acquire all your AMR requirements in your trial and future deployment from the vendor

As I have said before, the selection of a vendor is really a process of common sense thinking that will allow you to say that you can work with this vendor to achieve your goals of AMR deployment. You will not be able to get positive answers to all the questions asked but you must strive to achieve a feeling that your vendor of choice will be with you and support you during both the good and the bad phases of your AMR trial process and beyond to deployment.

The product selection process is also really a matter of common sense as well and can be sub-divided into five main areas of concern. They are listed as follows:

-Background
-Flexibility
-Cost
-Support
-Future

Again others may question the limiting of the areas of concern to only five, however I think if you can achieve a high degree of satisfaction with these areas your strategy will be successful.

From a background point of view with respect to product selection, you may want to ask some of the following questions.

-How long has this product technology been available in this form
-What is the product track record in other trials and deployments
-Does this product meet defined or emerging standards
-What is the experience of the vendor with this product in the market-place

-Where are the sales and marketing support groups located for this product

The next area of concern I have loosely labelled flexibility and I think it is the most important part of the product selection process. This area covers a wide range of topics.

-Will this product meet the trial defined configuration in a manner that is easy and economical to install
-Will this product work with existing products
-Can this product be upgraded or modified to meet additional minor undefined requirements
-What are the environmental characteristics of this product
-Can the product still be utilized if the regulations change slightly
-What level of expertise is required to install configure and maintain this product
-What are the technical limits of the product
-What are the physical limits of the product
-What are the safety limits of the product

I believe that the cost area is not as critical during the trial phase. Deployment of the product in any significant numbers without addressing the cost factors is however a serious concern.

-What are the product unit costs and break points of each trial component
-What are the ongoing costs associated with this product
-If software is part of the product, how user friendly is it
-If software is part of the product, how available is it to be utility reconfigured and deployed in other locations
-From an AMR perspective, if software is the controlling factor, how many reads per unit of time will this product allow
-From an AMR perspective, if hardware is the controlling factor, how many reads per unit of time will this product allow
-How much test gear and monitoring equipment is required to maintain this product
-Are the per unit acquisition costs for this product for each utility similar
-Are there any costs associated with this product that will be or need to be borne by the consumer

The support area of concern focuses on the requirements of the utility to support the product once it has been acquired, as opposed to the support of the product by the vendor as described in the vendor selection process.

- -What level of infrastructure is required to move this product from the trial phase to the deployment phase
- -What level of training will be required to deploy and maintain this product
- -If the product is software dependent, can it be utility manipulated
- -Can the software and hardware components of the product be upgraded by each utility
- -Will product support procedures be available from the vendor

The last area of concern in the product selection process can be determined once you know how well the product may perform and whether you can support it. Now where is this product going in the future. Here you need to ask the following types of questions.

- -Will the product be part of the utility full-deployment plans
- -If software is part of the product will it s current version or release be part of the full-deployment plans by the utility
- -What indications have come from the vendor that the present level of technology contained in this product will be upgraded or cnhanced
- -Will this product incorporate suggestions or design improvements that you as a utility may have suggested
- -Will any new AMR products from this vendor be compatible with the existing product line
- -Will new AMR products continue to meet existing or proposed standards

Basically when dealing with product selection, if the product selected can meet the requirements of the present and future needs of the goals of the utility in a cost-effective manner, then the product search has been successful.

As I have mentioned several times before, the vendor and product selection process is really a matter of common sense and staying within your desired goals. The questions that I have outlined on the preceeding pages are only a guide to give the reader a flavour of the type of questions to ask. I'm sure there are as many other, as-

important questions that could be asked, as there are people interested in AMR. However, sometimes in the enthusiasm to grasp a new technology to meet an existing problem, a utility may accelerate or inhibit the selection process and thus create new problems. If the steps as outlined in this paper are followed generally, but not necessarily in the order proposed, a successful AMR trial should ensue which would then allow confident steps toward full deployment.

Exciting new products from new and existing vendors are appearing on the marketplace today that will allow a wider scope for data collection, data access, data manipulation and data monitoring. Research is already underway to allow multiple technologies under the AMR umbrella to interwork with each other to meet future utility needs. The AMR technology has the potential to fulfill the present metering requirements and the future energy management demands for those utilities who use the vendor and product selection process appropriately.

QUESTIONNAIRE
POSSIBLE MULTI-UTILITY SERVICE TRIAL-AUTOMATIC METER READING AND DEMAND-SIDE MANAGEMENT

1. Utility completing this questionnaire

Gas	Water	Electricity	District Heating
☐	☐	☐	☐

_____ Other *(please state)*

2. Preferred location for trial

Downtown Core	Old, Inner Residential	New, Outer Residential	Outer Suburb Under Construction
☐	☐	☐	☐

(Multiple locations could be accommodated; tick as appropriate)

3. Possible trial size (number of meter locations)

0-100	100-500	500-1000	>1000 *(please state)*
☐	☐	☐	☐

4. Type of location

Private	Multiple occupancy	Institutional (hospital, government school)
☐	☐	☐

Industrial	Commercial
☐	☐

(Multiple types could be accommodated, please tick as appropriate)

5. Possible start date?

Third Quarter '92	Fourth Quarter '92	First Quarter '93	Second Quarter '93
☐	☐	☐	☐

6. Duration of trial?

One Year	Two Years	Semi Permanent
☐	☐	☐

7. Are you involved in, or planning for, multi-utility trials now?

Gas	Water	Electricity	District Heating		
					(others)

(show by linking)

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8. Services required from trial

8.1 Automatic Meter Reading

8.1.1 Frequency of read from Central Location (15 min, daily, monthly)

_____

8.1.2 Maximum turn-round time for a reading

_____

8.1.3 Is it required to transmit downstream (ie to the meter) in order to change registers for time of use?

_____

8.1.4 Type of meter output

a) ☐ contact closure (or Form C)

b) ☐ voltage pulse

c) ☐ does meter have encoded register?

☐ single

☐ multiple

8.1.5 What parameters have to be read?

Parameter					
Number of Digits					
Accuracy					
Frequency of Read					

8.1.6 Power quality parameters required to be metered

☐ ☐ ☐ ☐

8.1.7 Is it implicit that AMR is subsequently used for billing?

If so, what interfacing/uploading technique is required for the data?

What billing package might be used?

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8.1.8 Might the AMR mode be used alternatively (or additionally) for quality monitoring (say for load surveys?)

8.1.9 Is time of use required? ☐

If so, to what time accuracy? ☐

8.1.10 Is the data to be encrypted/decrypted? ☐

8.2 Load management

8.2.1 (Electricity) Is it required to load-shed by cutting off non-essential appliances? ☐

If so, how many locations in the house? ☐

How often? ☐

For how long? ☐

How rapidly (say locations/minute)? ☐

When restoring load, how rapidly (say locations/minute)? ☐

With what reliability (B.E.R.)? ☐

Maximum delay time to reception ☐

8.3 System performance monitoring

8.3.1 If so, what parameters?

Parameter					
Number of Digits					
Accuracy					
Frequency of Read					

(Could include, say, valve positions, temperatures, pressure drop, leakage, meterological information)

8.3.2 Approximate number of locations ☐

8.4. Is load survey data required? ☐

8.4.1 If so, what parameters?

Parameter					
Number of Digits					
Accuracy					
Frequency of Read					

8.4.2 Is recording capability required? ☐

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9. Technology

9.1 Have you a preferred technology? ☐

9.1.1 ☐ Radio

9.1.2 ☐ Telephone

9.1.3 ☐ Power Line Carrier

9.1.4 ☐ Cable Television

9.1.5 ☐ Satellite

9.1.6 ☐ Fibre Optics

9.1.7 ☐ Other

Note: Hybrid systems may be required, please mark accordingly.

Mark '1' or '2' for one or two-way communications

9.1.8 Reason for communications preference?

9.2 Would electric powering of the metering and control system be required at the remote location? ☐

9.2.1 ☐ Would uninterruptable power be required?

9.2.2 ☐ Or secondary cell and charging circuit?

9.2.3 If mains (hydro) power were required, could you arrange powering from

☐ the supply side of the meter?

☐ the subscriber's side of the meter?

9.2.4 What power drain (in watts, approximately)? ☐

9.3 What data require to be encrypted/decrypted? ☐

9.4 Would you consider the telecommunications carrier performing computations on your behalf? ☐

9.5 Issuing invoices on your behalf? ☐

10. Costs. How much would you be prepared to pay for the carrier for each read, for a large, permanent full-service offering?

<10¢	<25¢	<50¢	<$1	etc.
☐	☐	☐	☐	

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PROTOCOL / INFO SOURCE	SPONSORING ORGANIZATION	INDIVIDUAL
BACnet	American Society of Heating Refrigeration and Air-conditioning Engineers (ASHRAE) Special Projects Committee 135P	Michael Newman SPC 135P Chair
CE-Bus	Consumer Electronics Bus under developed by Electronics Industry Association (EIA)	John Ruiz OPC member
Echelon	Echelon LON protocol, Echelon Corporation license to be offered in the fall of 1990	Doug Dyment OPC member
EIB	European Installation Bus, development by 25-company consortium	Horst Gerlach OPC member
FND	Firm Neutral Data Transmission, German trial standard	Frank Carlen Corps Eng.
GOSIP	Government Open Systems Interconnection Profile U.S. Department of Commerce and National Institute of Standards and Technology (NIST)	Jerry Mulvenna NIST
MAP/TOP	Manufacturing Automation Protocol / Technical and Office Protocol. Corporation for Open Systems (COS) secretariat for Information Technical Requirements Council	Chuck Thurwachter OPC member
Profi-Bus	Performance Field Bus (German) proposed by Siemens, Bosch, and others, DIN V 19245	John Hettich OPC member
PWC	Public Works Canada (federal agency) developed under contract by Universal Software, Inc., Lynchburg, Virginia	James W. Ford PWC Director Ottawa
SP50/SP72	Instrumentation Society of America Field Bus Standard / Process Control Architecture	John Ruiz OPC member
TCP/IP	10-year-old communications integration protocol developed under contract to U.S. Dept. of Defense	Unassigned
TRON	The Real Time Operating Nuclei (esp. Macro-Tron) the Tron Association of Japan	Dennis Mool OPC member

Appendix V

B-LIST

Automated Meter Reading Association

ArcNet

ARINC 629 (aircraft)

Batibus (France)

CAN (car automotive network)

CENELEC TC 105

CSC (automotive automation)

D2B (Digital Data Bus)

FAIS, Factory Automation Interconnection Protocol Specification, 16-company consortium in Japan

FIP (factory instrumentation protocol)

Ford SCP (automotive automation)

HBS (home automation, Japan CX & TP)

IBM FACN (facility automation communications network)

I-Bus (building automation, Germany)

IEEE P1118 (Bitbus) industrial automation

IHS-Eureka/ESPRIT (home automation, Philips)

ISDN (telecommunications, USA)

ISO/IEC 10192 (HES) home elec. system

MilStd 1553 (avionics application)

SAE J1850 (automotive)

Smart House (Nat. Assoc. Home Builders)

X-10 (on-off powerline control, BSR)

ZVEI TC7.12 (building automation, Germany)

Appendix
Membership of the
CCAC Task Force On
Standard Data Communications Protocol
for Electronic Metering Devices
As of September 10, 1991

Glenn Allen
Ontario Hydro
Toronto, Ontario

Paul Aubin
Nertec Design Inc.
Granby, Quebec

William Beverly, Jr.
Aptech Corp.
Charlotte, N. Carolina

Tom Bowling
Tom Bowling & Assoc.
Kanata, Ontario

Alain Breton
SMIS
Sherbrooke, Quebec

Gordon Burns
Landis & Gyr
Lafayette, Indiana

Kah-Fâm Chan
Toronto Hydro
Toronto, Ontario

Gerard Chevalier
GE Canada
Quebec, Quebec

William Gibson
Process Systems, Inc.
Charlotte, N. Carolina

Alan Grightmire
Asea Brown Boveri
Alliston, Ontario

Michael Hajny
Jemtec Electronics Co.
Columbus, Ohio

Jean Joly
Hydro Quebec
Montreal, Quebec

William Kram
General Electric Co.
Somersworth, N. H.

Louis Lamarche
Hydro Quebec
Varennes, Quebec

Brian McKenzie
Endacom 2000 Inc.
Rexdale, Ontario

Jon Milliken
Fisher Controls Internat.
Marshalltown, Iowa

Vuong Nguyen
CCAC Legal Metrology
Ottawa, Ontario

Murray Reid
Nova Corporation
Edmonton, Alberta

Andy Seeger
ITT Barton
Calgary, Alberta

Ivo Steklac
Schlumberger Industries
Toronto, Ontario

Richard Tucker
Duke Power Company
Charlotte, N. Carolina

David Whelan
IRIS Systems, Inc.
Winnipeg, MB

Ed White
Utility Translation Services
Raleigh, N. Carolina

Jim Wong
TransCanada Pipelines
Calgary, Alberta

DRAFT 1992-01

MEETING MINUTES OF DATA PROTOCOL WORKING GROUP

AT HOTEL ROXBOROUGH ON 1991-12-11

Present :

Paul Aubin	Nertec Design Inc.
W. Beverly	Aptech, Inc.
Tom Bowling	TB & A
Kah-Fee Chan	Toronto Hydro
Jerry Erickson	ITT Barton Instruments
Jean Joly	Hydro Québec
W. Gibson	Process Systems Inc.
Paul Honchar	Equimeter Inc.
Michael Hajny	Jemtec Electronic Co.
William Kram	GE
B. McKenzie	Endecomm 2000 Inc.
A. Moise	Endecomm 2000 Inc.
Jon Milliken	Fisher Controls
Vuong Nguyen	CCAC
Murray Reid	Nova Corporation
Ivo Stekliac	Schlumberger Industries
Sumin Tchen	Adaptive Networks Ltd
Richard Tucker	Duke Power
Dave Whelan	Iris Systems

The meeting started at 1:05 PM on 1991-12-11 at Hotel Roxborough in Ottawa.

A. Moise chaired the meeting. Vuong Nguyen was secretary of the meeting.

Electronics and Wireless World (U.K.)

June, 19

BLOWN FIBRE – A NOVEL IDEA THAT MADE GOOD

A novel means of installing optical fibre inside buildings and outdoors has earned its inventor a medal for innovation as well as recognition from glass manufacturing concerns.

Known as blown fibre, the technique involves laying miniature conduits or ducts of polyethylene and running the optical fibre cables into them by blowing with compressed air. Because the technique is so straightforward and fast it is set to revolutionize the installation of optical fibre cables: by cutting the cost and time overheads of cabling it is likely to make optical fibres economic in fields up to now not considered appropriate.

Mick Reeve, the British Telecom research engineer who invented the unique system for installing optical fibre, was awarded the company's Martlesham Medal earlier this year in recognition of his idea. Reeve, who had spent more than 15 years researching the behaviour and performance of optical fibres, has shown that taking a radically new view of an old technology (cable making) can yield substantial benefits to the network operator. Not only did he invent the blown fibre process, but he also led the team in developing it to the point where it is now in large scale production and available from a number of commercial outlets. It is not often that European technology is licensed to Japan, but blown fibre is an example.

Like most of the best innovations, blown fibre is very simple. In the system, bundles of up to eight optical fibres, held together in a polyethylene sleeve, are simply blown into place down a small (3 to 6mm bore) tube or microduct. The microduct is tough and flexible and joints are made using ordinary push-fit connectors: it can be installed quickly and cheaply by unskilled labour. Once the microduct is safely in position, the fibre bundles can be blown through, using compressed air. The fibre moves briskly – at about walking pace – taking bends, junctions and vertical rises and falls in its stride, so the system works just as well inside buildings as outside under the pavement. Using tandem blowing heads the fibre can be blown in continuous lengths of several kilometres, without splicing.

When more capacity is needed on a route, the old bundles can be blown out and replaced with larger ones very quickly and cheaply. The whole process is fast, efficient and virtually foolproof – and both installation and upgrading costs are reduced.

How it works

The pace of optical fibre cable development at BT's Martlesham research laboratories was increasing after 1980, when Mick Reeve was put in charge of the Optical Cable Research Group there, working closely with all the major UK cable manufacturers to develop and apply new strain measurement techniques for optical fibres.

Mick Reeve, inventor of the blown fibre technique (picture from BT).

By 1982, it was very clear that optical fibres represented the way ahead. But there were still urgent practical problems to be solved. In particular, no-one had devised a wholly satisfactory way of putting the actual fibres in place, cheaply and efficiently, under field conditions, without straining or damaging them. It was at this point that Mick Reeve and his colleague Steven Cassidy began looking at possible installation methods. Compressed air had advantages as an installation medium but initial experiments using a bung attached to the end of a bundle of fibres were disappointing, and since the fibres were effectively being pulled along, they were being put under strain.

The breakthrough came when the fibres were observed to continue snaking through the tube even when the bung had left the end of the tube. Close examination of the experimental rig showed that the bundle of fibres was being carried forward by the viscous drag set up by the turbulent airflow around it. Instead of being pulled just from the end, it was tugged at every point along its length by the moving cushion of air.

Then the development work began. The microducts has to be just right – with the right bore and the right slip agents in the polymers. The design of the fibre bundles and the sleeve that held them together was critical, both in terms of signal loss and flexibility. Colour-coded fibres were needed, so that field engineers could tell which fibres to splice together. And there were other practical improvements to be made, such as the inclusion of a thread in each fibre bundle to make it easier to strip off the coating. Above all, it had to be shown that the production of the fibre cable could be scaled up to allow large quantities to be produced without quality problems.

The first installations

Mick Reeve's group set up an experimental cable-making plant on an industrial estate next door to the Martlesham site, giving them the opportunity to make cables using full-scale commercial extruders. As the practical problems were overcome one by one, the momentum increased and by late 1984 the blown fibre system was ready for a first trial installation, in Leeds. The result confirmed it – blown fibre worked just as well in the real world as it did in the laboratory.

After further successful field trials, blown fibre was used outside British Telecom for the first time in 1986, in a system carrying cables under the runways to the new Terminal Four at Heathrow Airport. The same year saw the first licensing agreement signed with Optical Fibres Deeside and the beginning of blown fibre installation in the British Telecom City Fibre Network in London.

Since then the pace has been stepped up even further, with the introduction of support tools such as tandem blowing heads and the ingenious rosette pans that allow installation teams to blow fibre in two directions at once. RAF bases such as Lyneham, Oldham and High Wycombe have been given multiple fibre optical cable routes. Blown fibre has now been used inside a customer's building for the first time, at British Petroleum's new headquarters at Hemel Hempstead.

The system has now been licensed to the largest fibre makers in the United States and Japan, Corning Glass and Sumitomo. ■

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STATEMENT OF WORK

DEVELOPMENT OF CANADIAN TELEMETRY OPPORTUNITIES FOR DISTRICT ENERGY SYSTEMS TECHNOLOGY

Background:

During the last few years, the International Energy Agency has been developing emerging technologies which promise to improve the cost effectiveness of integrated energy systems technologies; particularly district heating and cooling combined with cogeneration.

One of the areas investigated was the use of telemetry to monitor system function, provide active load control and remote meter reading service. This work was performed by a Canadian consultant with the support of an international team of experts. The resulting manual was very well received and recognized as a major contribution to this technology area.

While the merits of applied telemetry were recognized, it was determined that the cost of development and application of such a system could be too high. The concept was proposed that several utilities (ie. district heating and cooling, electricity, gas, water, telephone, cable TV etc..) could share in system thus receiving full benefits but with shared cost.

Since the report was issued in May, 1990, we have been meeting with Canadian experts to explore opportunities for further development and application. Interest in joint work has been expressed by a number of major companies and one municipal energy utility, Edmonton Power Corporation, would like to have their proposed cogeneration district heating and cooling project considered for a demonstration. This project is particularly interesting as the City also has control or influence on the electricity and water services which could also be integrated.

At a recent meeting of the Energy Systems Advisory Committee, this research area was discussed and was strongly supported for development as an important component of integrated energy systems control.

Objective:

Canada has an excellent telecommunications capability which could be effectively used for integrated energy systems technologies control and monitoring. Since these systems are showing serious promise for construction across Canada, it is required that a network of interested Canadian partners be identified, that they be informed of the potentials of the technology and that applications be identified which could form the basis of a feasibility study.

A preliminary list of such companies is attached of which several have already expressed strong interest.

It is expected that after this contract, private sector partners would fund all follow-up work, wholly or on a cost shared basis. The completion of the contract would result in two principal outputs:

1. Approximately bi-monthly reports summarizing technology developments and opportunities for Canadian companies developers and institutions; both for technology development and application. At the completion of the contract, a state-of-the-art report on telemetry technology and most promising opportunities.

2. Through consultation with Canadian energy utilities, select a site where the application of integrated telemetry technology could be most effectively applied, and complete a feasibility study as a basis for final design if warranted.

It is anticipated that this up-front funding by EMR would provide the confidence for private sector funding of follow-on development of detailed design, specification and construction.

As telemetry and related technology is quite 'generic', it is expected that the contractor will encounter other technology opportunities or applications that might be of special interest to the buildings research for internal energy management. Accordingly, it is expected that, through contact with engineering staff from EAETB, that pertinent information would be sought for intelligent building systems research.

Requirement:

The contractor will:

- on behalf of EMR, participate in meetings of lead associations active in telemetry and load monitoring or control including, but not limited to:

  - Intelligent Buildings Institute
  - Canadian and US Automatic Meter Reading Associations
  - Smart House Partnership

- provide bi-monthly reports on activities of these organizations highlighting new or significant technology developments, opportunities for Canadian manufacturers, and, cooperative ventures that may be available for Canadian researchers or manufacturers.

- based on bi-monthly reports and interest developed by participating interest groups, provide a state-of-the-art summary report suitable for dissemination to interested parties.

with the scientific authority, compile a list of Canadian research, industrial and utility groups who have a vested interest in the development and deployment of telemetry based metering/monitoring and control technology.

prepare an introductory paper to circulate to potential partners and interest groups to solicit involvement in a Canadian group whose common objective would be to exploit and further develop telemetry technology for energy systems applications and to implement a comprehensive system in an agreed site.

convene a meeting at a location that will minimize travel and related costs to the participants to outline EMR's objectives in this work and to jointly develop a program that will lead to development and application of a comprehensive telemetry based energy systems control, monitoring and remote meter reading capability.

where possible, define/negotiate work that might be done by participating groups so as to maximize the value of the project.

identify and select a demonstration site where there is a real commitment to fully consider this technology and to implement if a feasibility study indicates an economical application;

conduct a feasibility study for the chosen site to evaluate the viability of a comprehensive system which clearly outlines the system options and which clearly identifies the impact of multiple utility service as compared to single utility (eg. district heating alone) usage;

produce status reports at project milestones and a summary report that will report on:

- the state of the art of telemetry based technology for control, monitoring and remote meter reading for community based energy systems;
- key developments with Canadian and international partners within the context of this project including opportunities that were identified for exploitation by partners;
- description of sites discussed for a feasibility study and the rationale for the selection of a demonstration site;
- the feasibility study for the chosen demonstration site with sufficient information for a "go/no go" decision regarding final design and construction;

- recommendations about opportunities for focused Canadian work, niches for Canada that might be reinforced through further work and cooperation;

- recommendations about key international partners and organizations with which EMR and interested Canadian partners should be involved.

Timing and milestones:

The overall project should be complete by October 15, 1991 with a final report including the state of the art review, feasibility study and other items as identified above. However, individual item timing may be varied to satisfy the needs of partners in this work. This requirement refers principally to the feasibility study whose results must be available to coincide with the demonstration site decision point requirements. Any such changes in schedule must be agreed to by the Scientific Authority to be fair and reasonable requirements for the contractor.

Tentative milestones include:

1. Brief report to the IEA District Heating Group for October 26, 1990 to outline Canadian intentions and to invite involvement by international representatives.

2. Convene initial meeting of potential partners for the project on or before October 26, 1990.

3. Identify potential demonstration site by January 31st., 1991.

4. Provide Interim status report on the project for March 31, 1991 including special comments that may be of interest for discussion at the May IEA District Heating R&D meeting.

5. Complete feasibility study of demonstration site by July, 1991.

6. Complete draft final report for project by Sept. 30, 1991, and final report by October 30, 1991.

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Glen Williams Consumers Gas

Leave that for now because potential suppliers of equipment will get involved.

Tom Bowling Tom Bowling and Associates

We need to get at systems needs, then we need to approach companies. The project needs careful management. Remember it is a trial and not a full implementation.

Mike Wiggin Energy Mines and Resources

Do we need one Toronto based person to be the focus?

Tom Bowling Tom Bowling and Associates

I can project manage the trial.

Roger Levesque Bell Canada

We should have a steering committee.

Gerry Dennis Consumers Gas

I will provide a meeting room here in Toronto.

Roger Levesque Bell Canada

Can we specify when a trial will start and how long it will take?

Tom Bowling Tom Bowling and Associates

Regarding duration, we need at least four seasons, probably two years.

Kah-Fae Chan Toronto Hydro

I am concerned about Toronto hydro being willing to support this and our present trial in parallel.

Mike Wiggin Energy Mines and Resources

Is there any other business?

Tom Bowling Tom Bowling and Associates

Yes. I would like to propose a symposium. Lasting a t least one day and possibly as much as three (Chart 8).